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THE TOTAL SOLAR ECLIPSE, JANUARY 22, 1898.

By E. Walter Maunder, F.R.A.S.

THERE could hardly be a greater difference than between the eclipse of 1896 and 1898. The shadow track in the former case ran through a vast extent of country which offered, however, but few suitable sites. These were clustered together at two or three main points, and in almost every case the intending observers were disappointed of the spectacle which they had come to see. In 1898 the eclipse track lay chiefly in one single country which offered a large number of easily accessible sites, nearly all of which were occupied, and all were favoured with the most perfect weather. Up to the present time it certainly is the record eclipse, either as regards the number of observers, the character of their equipment, or the unchequered favour which they experienced from the weather.

"A victory all along the line," is what we have to record. The full significance of that victory and what results may accrue from it, it will take us many months to learn.

As a sensation the eclipse did not fulfil the popular descriptions. Whether, as has been asserted, the corona was unusually large and bright, or from the special atmospheric conditions prevailing in India at the time, the darkness was much less than is usual in any eclipse of two minutes' duration, and the general effects in colour, light, and the appearance of the landscape were very much those which were brought about more slowly some four and a half hours later some thirty-five or forty minutes after the sun had set. At any rate, the light at mid-totality was certainly greater, considerably greater, than we ordinarily get at night at the full of the moon.

The fall of temperature was, however, considerable, amounting to some twelve degrees; and it was noticed by some of those who had taken part in the Norway expedition of 1896 that, whereas on that occasion the darkness of the eclipse was felt to be a sensible relief from the unceasing sunlight, so now the coolness of the eclipse was a relief from the too powerful heat of the sun.

Consistently with the small amount of darkness of the eclipse the approach of the shadow at the beginning of totality was less marked than usual, and in some places, though watched for, escaped notice. The only record that has yet reached me of its approach having been distinctly observed is from Dr. Robertson, of Nagpur. The shadow-bands were also looked for at some stations without success, though they were caught at both Jeur and Nagpur. At the latter place Miss Henderson, M.D., describes them as having been faint dusky ripples some two inches in breadth, and separated from each other by about the same interval, and in appearance and speed of motion resembling the ripples seen on the ceiling of a cabin in an ocean steamer as they are deflected through the porthole from the water outside.

Of the stars visible during the eclipse one caught every attention, and was, indeed, seen after totality had passed. This was the planet Venus, some six degrees south-west of the sun at the time. Mars, though very small and further from the sun, was also glimpsed, and some two or three other stars were noted.

The shape of the corona recalled at once that of 1896, and with it the two earlier years 1868 and 1886, which it had resembled. To the south-west a long ray nearly in the solar equator was easily traceable for two, if not three, solar diameters from the dark limb of the moon. On the east side a pair of broader and less-extended streamers formed a single connected structure in which the characteristic coronal curves were repeatedly seen.

Bearing in mind that these four years all fell at the time of small but not of minimum sunspot activity, it appears clear that we have here brought out a third coronal type as distinct and definite—perhaps even more so than those which have been already recognized as appropriate to the times of actual maximum and minimum; and it may be hoped that we have now material enough to enable us to trace the course of change which the corona undergoes in its passage from one extreme form to the other.

It may be opportune here to correct a widespread misapprehension, that minimum coronæ are small and faint except for the two great equatorial rays. The reverse would seem to be the case, except in the immediate neighbourhood of the sun's pole. The corona, for instance, of 1878, so far from being small and faint, was unusually large and bright; and the present one, though we have not yet reached the actual minimum, possessed the same characteristics.

The feathery structure round the solar poles, which was so plainly seen in the eclipse of 1878, and which has been recognized more or less clearly at so many eclipses since—

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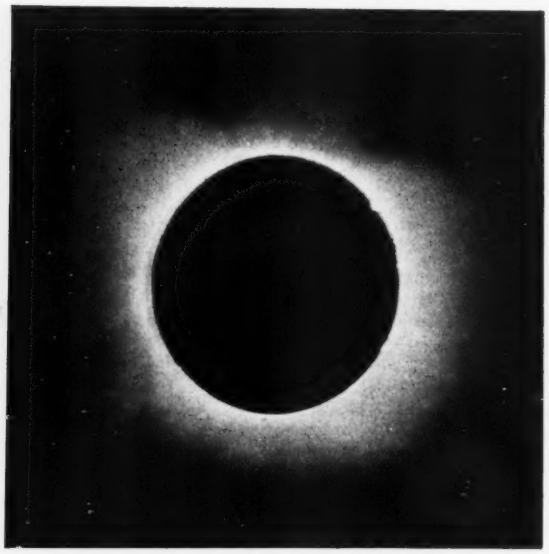
especially at or near the time of minimum—was very apparent on the present occasion.

The photographs of the corona have been unusually



The Sun's Corona, Total Eclipse, January 22nd, 1898.

numerous, and have been taken on every variety of scale, from a diameter of a single millimètre with a hand camera, up to one a hundred times as great. The latter were obtained at three stations: by the Astronomer Royal at Sahdol, with an aperture of nine inches and an enlarging lens; by Dr. Copeland, at Gogra, near Nagpur; and by Prof. W. W. Campbell at Jeur, with telescopes of about forty feet focal length. Next in order to these giant photographs come the standard instruments of the Joint Eclipse Committee, with their twin cameras giving images of an inch and a-half, and of six-tenths of an inch. These were employed by Prof. Turner at Sahdol, and Captain Hills at Pulgaon. The cameras taking photographs of one inch in diameter and smaller were much too numerous to recount; but special note should be made of Prof. Burckhalter's device for obtaining both the inner and outer corona on the same plate by means of a revolving screen worked by a spindle passing through a hole in the centre of the plate, which diminished the exposure given to the bright central regions of the corona so as to bring it more in accord with the faint light of the outer extensions.

At the extreme ends of the line of stations a novel experiment in coronal photography was attempted. At Buxar, on the Ganges, and at Viziadrug on the coast, a kinematograph was employed so as to obtain a continuous series of photographs of the progress of the eclipse. The former instrument was supplied by Mr. Nevil Maskelyne, and was worked by the Rev. J. M. Bacon, the astronomer in charge of one of the two parties organized by the British Astronomical Association, and the other was in the hands of Lord Graham.

Of direct visual spectroscopic observations there were few. Mr. Newall and myself endeavoured to trace the distribution of coronium—that is, of the substance which shows its presence in the 1474 K line; but the line was faint, and it could only be ascertained that it showed a general conformity to the shape of the brighter part of the inner corona, without its being possible to ascertain whether it corresponded in minuteness of structural detail. No rifts were detected in it.

The photographs of the spectrum claim the highest interest, and these were of unprecedented number and value. Captain Hills, at Pulgaon, with two great slit spectroscopes, obtained records of the "flash," both at commencement and end of totality, which give a complete history of the spectroscopic changes seen in the various strata of the sun, from its ordinary spectrum up to that of the prominences at Viziadrug on the coast. Mr. Fowler and Dr. Lockyer were equally successful with prismatic cameras of six inches and nine inches aperture, whilst smaller spectrographs of extreme beauty, and ranging from C in the red far into the ultra-violet, were secured by Mr. Evershed at Talni.

The examination and interpretation of these photographs will be the work, not of days and weeks, but of months, and possibly years; but we may confidently look to them for a complete answer to many questions which are engaging the attention of solar physicists at the present time, and particularly for information as to the exact *locale* of the absorbing vapours which give rise to the Fraunhofer lines. Sir Norman Lockyer's theories, in particular of dissociation in solar and stellar atmospheres, will be put to the severest test, and our knowledge of solar mechanism can hardly fail to receive a great advance.

One inquiry which it was hoped the present eclipse would advance has failed to meet with success. Mr. Newall was endeavouring to ascertain if the spectrum of the corona, as obtained from the two opposite limbs of the sun, gave any evidence of relative motion in the line of sight due to rotation. It will be remembered that in 1893 M. Deslandres came to the conclusion that the corona rotated in essentially the same period as the photosphere. Mr. Newall had arranged an exceedingly beautiful instrument for this purpose—a spectroscope, the collimator view telescope of which was parallel to the polar axis. The spectroscope was also provided with a double slit, the one slit tangential to one limb, and the second to the other limb; the one slit stretching from the sun's equator northward, the other from the opposite end of the equator southward. The experiment, which abundantly deserved to succeed, was, however, frustrated by the faintness of the coronal spectrum.

Of other observations it is scarcely possible to speak as yet. It should, however, be added that the polariscope, which has been almost forgotten in eclipse work for the last fourteen or fifteen years, was very successfully used, both at Sahdol and at Pulgaon, and the clearest indications were secured of strong radial polarization.

Such is a very brief outline of the principal results (so far as we yet know them) of this the most completely successful eclipse on record. We hope to be able, at no very distant date, to go much further into detail, when some portion of the photographs obtained have been deciphered and discussed.

BRITISH BEES.—I.

By Fred. Enock, f.l.s., f.e.s., etc.

THE number of species of bees in Great Britain is by no means large—only just over two hundred—and yet to those people who, "having eyes, see not," this small number is far too large for insects which possess stings. Gardeners, too, look upon them as marauding thieves, and this in spite of the fact

that fertilization of plants is brought about by the unceasing industry of the bees.

Ungratefulness in man is so common a characteristic that we must not be surprised to find that so little interest is taken in the study of our British bees. It is sufficient for the majority to know that "bees make honey."

For those who *do* desire to be soothed by the humming-bee, or to follow out the habits and economy of our British bees, the choice of books on the subject is by no means a large one. They are: "Bees of Great Britain," by Frederick Smith; Shuckhard's "British Bees"; and the most valuable work, "The British Apidæ," by Edward Saunders. Mr. Saunders is always ready and willing to help young students in naming their captures. It is one of our greatest pleasures to look back upon the many instances of kindness received from the late Frederick Smith, who was in every sense a true lover of bees—one who would inspire enthusiasm in the heart of a young beginner. The collection of British bees at the Natural History Museum, South Kensington, was under his affectionate care years ago at the British Museum.

The first family, the *Andrenidæ*, is divided into two subfamilies: the first composed of two genera only, possessing tongues much like the *Vespidæ*, obtuse and rounded; that of *Colletes* being very beautiful when fully expanded (Fig. 1, *Colletes Daviesana*). There used to be a very large colony of this species at Farnborough, where I have seen hundreds of the burrows close together in the sand-banks. In some of the woods near Aldershot there were also a number of colonies, many of which appear now to have become deserted. The exceedingly neat looking species, *C. succincta*, I used to find at Hampstead Heath, but, like other things, it has now disappeared from that neighbourhood. The bees of this genus have exceedingly sharp and powerful stings, and the legs are clothed with most beautiful hairs of varied form.

The members of the other obtuse-tongued genus, *Prosopis*, are all small in size and more or less black. They are exceedingly fond of the flowers of the vetch. The males are most diligent in their pursuit of the females.

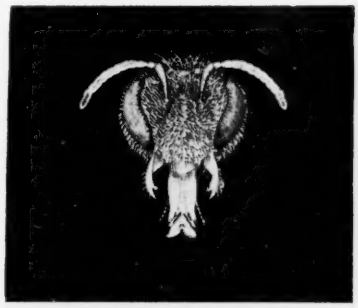


Fig. 1.—*Colletes Daviesana.*

The second division, in which are classed those bees possessing tongues more or less acute, is composed of a number of genera. Like those of the first part, the members of these genera are solitary in their habits. The females burrow into the sand for some considerable depth, and line the sides of the burrow with an exceedingly fine membrane, resembling goldbeaters' skin—only considerably thinner.

The bees belonging to the genus *Sphecodes* are small, measuring from three-eighths to half an inch long. They have black heads and bright, shining red bodies. They are fond of settling on the bare patches of sand at Hampstead and in other places where they are tolerably plentiful, the females being more so than the males. The sculpture of the thorax is well worth examination.

The next genus, *Halictus*, is composed of many species, of some which are *very* small, but all are exceedingly neat in their appearance. Both sexes of many species appear in September, when, after impregnation, the females hybernate, and make an early appearance the following spring, when they are busily engaged forming burrows in the sand. Many species are very fond of the flower of the dandelion, and may frequently be found curled up asleep in a half-closed flower. A close watch on these and other flowers during the early hours of the day will often be rewarded by good captures. The tongues of all the *Halicti* are long and lanceolate, and require great care and patience to expand and set out so that all the exquisite structure may be revealed.

We next turn to the genus *Andrena*, which contains the greatest number of species both rare and beautiful. In this genus are the bees which herald the approach of spring. Many of them visit the opening catkins of the willow, and, like the Lepidoptera, soon become intoxicated, and fall an easy prey to the first prowling naturalist. It is, indeed, a glad time when, after weeks of cold and foggy weather, the bright sun breaks out, bringing with its genial warmth these pretty brown bees, each one arrayed in such a perfectly fitting costume of plumed hairs, and their delicate wings glinting in the sunshine—for bees must have bright sunshine to enjoy their lives to the full. I have often heard the remark that it is not much or any use going out in search of bees before nine o'clock in the morning. This was specially impressed upon me when receiving directions as to how, when, and where to look for that most extraordinary parasite *Stylops*, which is found in the abdomen of several of the *Andrenæ*; but having formed some original ideas concerning *Stylops* I am afraid I quite disregarded most of my friend's instructions. Instead of nine o'clock, I was on the ground before eight—waiting for the bees—and as they seemed to be rather behind time I commenced to search for their burrows, which, after a little experience, I was enabled to detect by noting the disturbance of a few grains of sand. By quickly inserting the bent end of my digger (an old half-round file) a short distance away from the burrow, I was able to heave out in nine times out of every ten the *Andrena*, with the moisture clinging to its still yet untried wings. Its astonishment at being so unceremoniously "lifted" appeared to deprive it of the power of sudden flight, and before it could recover it was under close examination, and if stung by *Stylops* it was boxed at once. I placed many of these "stylopized" *Andrenæ* in various parts of Hampstead Heath, hoping to establish the parasite in parts somewhat remote from the area so dear to the holiday makers during Easter (the time when many species of *Andrenæ* are most plentiful), but Hampstead Heath has, within the past twenty years, considerably altered its appearance. Where there used to be rising sandbanks, the head-quarters of endless bees and sand wasps, there is now an unsightly cinder path crossing the very spot which was once the citadel of these beautiful bees, and where, in July, could be seen dozens of the burrows of the sand wasps, *Cerceris arenaria* and *ornata*. Last year I visited this locality several times, but not a single *Cerceris* did I find. The beautiful *Andrena fulva*, with its bright chestnut-coloured abdomen, has not, I am rejoiced to say, yet been exterminated, though how long it will be able to exist time alone will show. Its bright colour is too tempting to the sharp eyes of Easter Monday Cockneys. Fig. 2 shows the head and mouth organs of *Andrena fulva*, which, together with others of the genus, burrow deep down into the sand, throwing up quite large heaps, which frequently are trodden flat to the ground when the industrious female is out collecting pollen

and nectar. On her return there is no sign of her home, but she, possessing the bump of locality to a large degree, sets herself to work to find or make an entrance through the hardened sand. This she proceeds to do by removing the sand with her powerful mandibles, which are frequently worn down until they are made stumpy in her efforts to reach her burrow—efforts terminating in success.

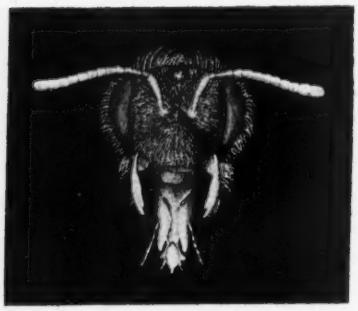


Fig. 2.—*Andrena fulva.*

The male of *A. fulva* has its mandibles enormously developed. Some of these bees, on first emerging from their burrow, are exquisitely arranged and exact in every fringe of hairs, on head, abdomen, and legs. One of the neatest is *Andrena fulvicrus*, which is markedly common at Highgate Cemetery—a good locality for many kinds of bees, where they can live and die in peace. The neighbourhood of Highgate Archway, too, used to be a noted spot for uncommon *Andrenæ*, such as *A. longipes*; but now it sounds like mockery to mention such localities as Copenhagen "Fields" and Highgate "Fields."

Leaving the *Andrenæ*, we now come to a bee, *Macropis labiata*, of which, when the late Mr. Fred. Smith wrote his "Bees of Great Britain," in 1855, only three specimens (all males) were known to exist. The first captured in this country found its resting place in the British Museum; the second was taken by Mr. Walton in the New Forest; and Mr. Samuel Stevens captured a third at Weybridge, on July 4th, 1842; and though the surrounding country had been searched year after year, it did not yield another specimen. Not until the year 1878 was this rare bee heard of again, but then the well-known hymenopterist, Mr. Bridgman, appeared at the right time and right place to find both males and females. In 1882 I went to live at Woking, which was then a comparatively small place. At that time I used to wander about without interference, and I could revel in studying insects, especially bees. Previous to taking up my abode at Woking a microscopist asked me what I was going to take when I got there. I immediately replied, "Oh, *Macropis*," adding, "I will write and let you know immediately I capture it."

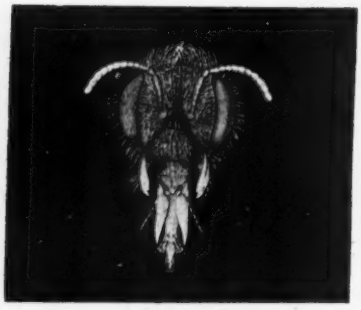


Fig. 3.—*Cilissa hæmorrhoidalis.*

In the following July I observed large quantities of a flower somewhat new to me, upon which I kept constant observation—having a presentiment that I should find *Macropis* upon or about it. On July 27th, 1882, my valued friend, the late Sir Sidney Smith Saunders, paid me a visit, and we both went out "beeing." At noon exactly I noted a bee pass by whose hum I did not know, so I waited until it should return, which it did in a few minutes—little suspecting that it was doomed to be captured, by a rapid stroke from my arm. I quickly removed it from my net and brought my magnifier to bear; I then called to Sir Sidney to come and have a look at something, asking, as I gave it into his fingers, "What's *that?*" when after a few moments' pause Sir Sidney almost shrieked with excitement, "Why, it's *Macropis!*" I boxed it safely, feeling that my presentiment had indeed come true.

After this piece of fortune Sir Sidney and I were much excited, and jumped hither and thither like parched peas; but all in vain that day—no more *Macropis* appeared.

On the 29th I was found on the spot with eyes and ears at full cock; my patience was rewarded by capturing four more male and one female *Macropis*. I quickly discovered the fact that the latter knew how to sting. After my first capture I sent a card to my friend, informing him that "I had got *Macropis*."

Sir Sidney S. Saunders and I had several rambles together in search of this beautiful bee, and each was rewarded by capturing several males and females. The following year, 1883, I saw dozens of both sexes, which I left to be fruitful and multiply. I searched in vain for their burrows, though I tried all kinds of dodges. Catching some, I gently tied a delicate piece of fine silk to one of the legs, then a small piece of white tissue paper, and started the bee flying. I followed the bees long distances, but all my efforts were futile. Some of the "runs" ended by my catching my foot in a twig and falling headlong into a gorse bush, from which I was glad to retire as soon as possible. Woking has since increased to five times the size, and some of the best parts of the common are utterly ruined.

Another beautiful bee which I used to find occasionally in the neighbourhood of Woking was *Cilissa hæmorrhoidalis*, which affects the flowers of the harebell—another flower that is not so plentiful as in years past, but one absolutely necessary to this bee—one of the most energetic and businesslike insects with which I am acquainted. Quick eyes and hands are needed to capture this prize, for it only appears in the hottest sunshine, when everything must be ready for its reception. It announces itself without a moment's hesitation, and does not tarry long, for it is no sooner in one harebell than it is out again and away—except, indeed, when the net follows up as quickly. Even when it is in the net the capture is not complete, for this bee does not sham death as do others, but bustles about in a most vigorous manner in its endeavours to escape, stinging, too, in the most approved style. I do not think any bee possesses such an exquisitely beautiful tongue as this one. In outward appearance this bee is much like a large honey bee, though much more hairy. Fig. 3 gives an idea of the head and tongue. Whilst searching for *Cilissa* I used occasionally to find a few of that grand bee, *Dasypoda hirtipes*—the hairy bee—without doubt the most beautiful and graceful of all British bees. It has only once been

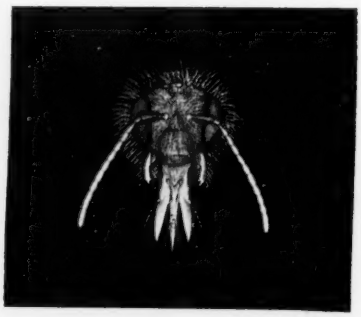


Fig. 4.—*Dasypoda hirtipes.*

recorded from the London district—July 18th, 1878—when I was fortunate in capturing a fine female specimen as it hovered about the face of a sandbank on Hampstead Heath. *Dasypoda hirtipes* is intensely fond of composite flowers of the dandelion type, among the petals of which it buries itself as it rifles the flower of its nectar and yellow pollen, with which it becomes heavily laden. Its immense bushy hind legs look like bright yellow bottle brushes. The shape of the hairs on the third pair of legs is unique among bees, each tiny little branch being surmounted by a knob or club. This bee is plentiful along the south coast. I found them just emerging from their burrows in the sand at Littlehampton. Fig. 4 shows the peculiar shape of the tongue and maxillæ.

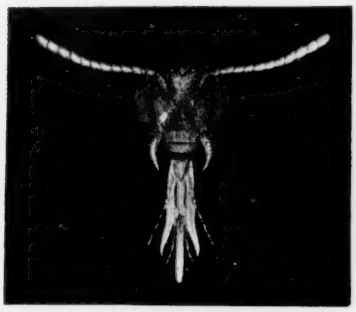


Fig. 5.—*Nomada succincta.*

Panurgus is the next in order. In colour it is a smoky black. It is fond of making its burrows in hard paths, and in such situations I have found them at Woking and Hampstead, besides having swept them up from flowers of the mouse-ear hawkweed, which used to flourish on Hampstead Heath.

The genus *Nomada* consists of a number of species, more like wasps than bees, with bright yellow-banded bodies. All are cuckoo bees, depositing their eggs in the burrows of *Andrenidæ* at the time when the rightful owners are engaged storing up pollen for their progeny, which are starved out by the stronger larvæ of this cuckoo bee. The tongue is a very neat one, more resembling that of the honey bee (*see* Fig. 5).

The prettily marked bee *Epeolus variegatus* is parasitic in the cells of *Colletes Daviesana*. It has a particularly sharp sting. (*To be continued.*)

THE VINEGAR EEL.

By C. Ainsworth Mitchell, B.A., F.I.C.

In the "Philosophical Essays" of Robert Boyle, published in 1661, there occurs the following paragraph:—"We have made mention to you of a great store of living creatures which we have observed in vinegar; of the truth of which observation we can produce divers and severe witnesses, who were not to be convinced of it until we had satisfied them by ocular demonstration; and yet there are divers parcels of excellent vinegar wherein you may in vain seek for these living creatures, and we are now distilling some of that liquor, wherein we can neither by candle-light nor by daylight discern any of these little creatures, of which we have often seen swarms in other vinegars."

This appears to be the earliest reference in scientific literature to the *Leptodera oxophila*, which, from its shape and fondness for vinegar, has long been known as the "vinegar eel," and which in Schneider's opinion is identical with the "eels" which may often be observed in sour paste.

It is of very frequent occurrence in certain vinegar works, more especially on the Continent, where the vinegar is manufactured at a lower and (for the eels) more favourable temperature than is usual in England. As to its origin, nothing is definitely known, though Czernat is inclined to think that it is introduced in the water used for brewing the vinegar. Occasionally, on allowing vinegar to stand exposed to the air for several days in warm weather, it will soon be swarming with these minute creatures, which have probably developed from germs already present in the liquid. As will be seen from the figure, which shows a single vinegar eel under a high power, it is of very simple construction.

The body is cylindrical and ends in a sharp point, and the skin (which is changed from time to time) is smooth, structureless, and very strong. According to Czernat's average measurements, the length of the male's body is about one twenty-fifth of an inch, that of the female one sixteenth of an inch, the relative proportion generally being as 1 : 1·3. In both sexes minute corpuscles may be observed, which are put in motion by the contraction of the body. In the female the eggs lie in two tubes which unite in one opening.

Vinegar eels are capable of moving either backwards or forwards, and progress by alternately shaping themselves into an S and straightening out again. They appear to be incessantly darting through the vinegar at the top of their speed in all directions, but always with a tendency towards the surface, as they are air-breathing animals. Czernat states that they never rest day or night, and that their rate of progress is about one inch in twelve and a-half seconds.

They are capable of living in very dilute alcohol or acetic acid as well as in vinegar, and can withstand a great variation of temperature, not being killed until the temperature reaches one hundred and forty degrees to one hundred and fifty degrees Fahrenheit in one direction, and about ten degrees below the freezing point of water in the other.

The Vinegar Eel (highly magnified). (*After Pasteur.*)

Pasteur was the first to point out how harmful the vinegar eel is in the manufacture of vinegar. Vinegar is prepared by causing certain micro-organisms (of which there are several species classified under the term of "acetic bacteria") to act upon a liquid containing a small percentage of alcohol, such as beer, fermented malt extract, or cider.

By the action of these bacteria, which are supplied with the requisite amount of atmospheric oxygen, the alcohol is gradually converted into acetic acid, the process being accelerated by maintaining a temperature of about one hundred degrees Fahrenheit within the "acetifier."

When insufficient air is supplied, the bacteria form themselves into a slimy layer on the surface of the liquid, popularly known as "mother of vinegar." Should, now, vinegar eels develop in vinegar in the course of manufacture, they multiply rapidly, and a struggle for the air supplied to the apparatus commences between them and the bacteria. For some time a working balance may be struck between

them, and the air shared; but during this struggle, which may last for weeks, the activity of the bacteria is impaired, and though the conversion of alcohol into acetic acid still proceeds, it does so with an increased expenditure of time and a reduced yield. Should the vinegar eels gradually obtain the upper hand, they interfere more and more with the working of the apparatus, and eventually the conversion of alcohol into acetic acid comes to a standstill. If, on the other hand, the bacteria get the mastery, they form the slimy layer, mentioned above, over the surface of the liquid, as the result of their obtaining insufficient oxygen. This skin effectually prevents the eels from breathing when they come to the surface, and so they perish for want of air, and fall to the bottom of the apparatus, where they may accumulate and putrefy. In either case the only remedy is to thoroughly clean and disinfect the apparatus and commence afresh.

It was only with great difficulty that Pasteur could convince certain French vinegar manufacturers as to the advantage of endeavouring to get rid of the vinegar eel, for so general had it become with them that they had begun to look upon it as an essential part of the process instead of a deadly enemy.

Even after vinegar containing eels has been freed from them by filtration the germs remain, and when placed under suitable conditions will develop into eels, which will rapidly multiply and cause the vinegar to become turbid, although it has been recently proved in Germany that they do not affect its strength. As Pasteur was the first to point out the ill effects caused by the vinegar eel in the manufacture of vinegar, so, too, he was the first to devise an effectual means of destroying them, with their germs and all other forms of life in the finished product, by heating it to about one hundred and sixty degrees Fahrenheit, and then rapidly cooling it so as to prevent loss of the acid by evaporation. And this is only one of the many instances in which the studies of Pasteur on micro-organisms have been of practical benefit to mankind.

BOTANICAL STUDIES.—II.

COLEOCHÆTE.

By A. Vaughan Jennings, F.L.S., F.G.S.

In a preliminary study* we examined a common fresh-water alga which showed in its simplest form the process of oögamous reproduction; the development of a single egg-cell in a simple protective case, fertilized by motile antherozoids formed in an adjoining chamber growing out from the same plant-filament. Apart from structural details of the plant in question, attention was specially called to two points in connection with its reproduction: firstly, that what might be termed the "fruit" was only the fertilized egg-cell surrounded by a thickened wall; and, secondly, that on germination this "fruit" (or oöspore) grew at once into a new plant, in all respects resembling the parent.

Our next illustration may also be taken from the fresh-water algæ, and from a genus by no means uncommon in this country, though not, perhaps, easy to find without some careful observation.

On the stems of water plants such as the water-lily and the common pond-weed, or on the glass sides of aquaria, may be found little green discs ranging in size from almost invisible specks to circles a quarter of an inch or so in diameter.

* *Vaucheria*, Knowledge, January, 1898.

These belong to the genus *Coleochæte*,* a well-defined and widely distributed genus containing in this country some three species. The plants are, it is true, very frequently sterile, but the nature of the reproductive process is of considerable importance in the line of study we are following.

It will be interesting, however, first to examine the structure of the plant itself. If the species collected is, as it most probably will be, either *C. scutata* or *C. orbicularis*, it will be noted that the whole plant is just a flat plate of cells arranged in radial rows; the cells all in one plane and never superposed one above another. As the cells have all a fairly uniform average size, this must mean that at the growing margin many cells divide in two by radial walls, and numerous instances of this will readily be found. In another species—*C. soluta*—the rows of cells are, in fact, separated for a considerable portion of their length: while in others, such as *C. pulvinata*, the cells are no longer in one plane, but grow up straight or obliquely, forming a sort of cushion.

In other words, we have within the genus† a series of stages connecting the flat cell-plate with the tree-like growth of such types as *Bulbochæte*, one of the most beautiful of our fresh-water algæ. Among the red sea-weeds, also, the early stages of some species of the "coralline" *Melobesia* have a similar structure, and the delicate discs of cells may often be found on the surface of the larger weeds. A similar growth-type occurs also on leaves in tropical countries, constituting the genus *Phycopeltis*,‡ but here a yellow colouring matter is present as well; and this fact, together with its reproductive organs, shows it to be allied to the little yellow or red filamentous algæ of the genus *Chroölepus* (or *Trentepohlia*) which occur on rocks and trees all over the world. We have, that is to say, similar or parallel types of growth in plants which are otherwise widely separated. Some writers seem to regard the disc type as derived from the thread-like form; but the early stages in development of such forms as *Phycopeltis* seem, as I have elsewhere suggested,§ to point to an opposite conclusion. Theoretical questions such as this are, however, outside our present purpose.

Coming to the question of the mode of reproduction in *Coleochæte*, we find, as in *Vaucheria*, that there are two distinct methods. In the first case the protoplasm of some of the cells of the thallus becomes contracted and rounded, and finally escapes by an opening in the cell wall. When liberated it appears as a free-swimming *zoögonidium* with a pair of long cilia. This, after a period of activity, loses its cilia, settles down, and subsequently grows into a new plant. The process is therefore physiologically similar to the escape of the more complex *zoögonidium* of *Vaucheria*, and has nothing to do with the formation of a true fruit. It is again a case of "rejuvenescence" of a protoplasmic particle without any combination with other elements.

In the second case the contents of certain cells become enlarged and specialized to form an *oösphere*, while some of the other cells divide in four, and from each new cell

* The name refers to the long bristle-like hairs with a sheathing base which occur on the cells of the disc in most species, but are sometimes altogether absent.

† The closely related genus *Aphanochæte*, which also occurs on fresh-water weeds, shows in the same way an intermediate condition between the discoid and the filamentous growth.

‡ The *Mycoidea parasitica* (Cunningham), which causes disease on the leaves of the coffee and other plants, is nearly related, but may consist of more than one cell-layer, and may penetrate the tissues of the leaf it grows on.

§ *Proceedings of the Royal Irish Academy*, 1895.

thus produced set free an *antherozoid*. This is a free-swimming body with two cilia, similar to the zoögonidia, but smaller, and it reaches and fertilizes the oösphere by different methods in the various species. In the common British species it appears that any cell of the disc may enlarge and become an oögonium; and, similarly, other cells may divide and become antheridia, though often on separate plants. The fertilization of the oöspheres by the antherozoids in these cases apparently takes place by the passage of the latter through an opening in the cell wall of the oögonium.

The process has been studied in detail by Pringsheim in the case of a species which is not found in this country—*Coleochæte pulvinata* (A. Br.)*—and in this case the highest degree of specialization seems to be reached. The species is one of those already referred to as having a half-filamentous, tufted growth, and here the oögonia are terminal on the ends of the threads.

The oögonium is, as before, only an enlarged and specialized cell containing a single oösphere, but its wall is prolonged into a long tubular projection termed a "*trichogyne*." Antheridia are developed from adjacent cells in this species, but in some other cases on separate plants.

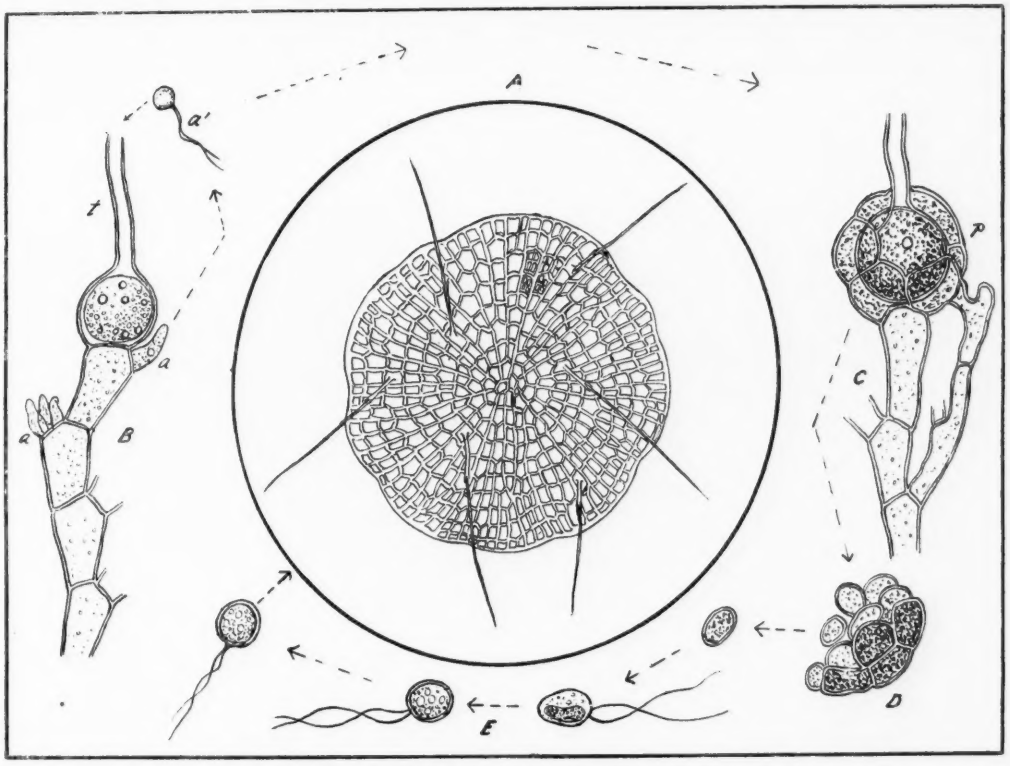
There is no doubt that the trichogyne corresponds in function to the *style* of a flower, and is a special structure developed in connection with the process of fertilization. Its presence in this one type of fresh-water weed is specially interesting, because it is a characteristic organ in the case of the red seaweeds, though in these the fertilizing agents are non-motile bodies or *pollinoids*.

This similarity between the reproductive process in *Coleochæte* and in the red seaweeds is still more marked in the subsequent stages. After fertilization not only does the oösphere enlarge and become surrounded by a cellulose wall (constituting an oöspore or oösperm), but some physiological influence extends to the adjacent cells, causing them to divide and grow up round it, enclosing it in a protective cellular layer or *pericarp*.

The structure thus formed—which has been called by different authors a *carpogonium* or *spermocarp*—is therefore a very much higher type of fruit than the simple oöspore of *Vaucheria*.

The fruit remains quiescent during the winter, but in the next spring the oöspore divides and forms several cells or *carpospores*; it does not itself grow into a new *Coleochæte* plant. Further, the carpospores themselves do not grow into new vegetative plants. They liberate free-swimming zoöspores, and these in their turn give rise to new *Coleochæte* plants which may reproduce themselves again by either method.

While, then, an ordinary sterile plant of *Coleochæte* does not show us any particular advance in general structure from many of the lower *Thallophyta*, there are certain well-



A.—Young plant of *Coleochæte scutata* (Brèb), magnified about one hundred times. In the upper part some of the cells are dividing into four previous to the development of antherozoids. B.—A fertile filament of *C. pulvinata* (A. Br.), showing the oösphere enclosed in the oögonium with its trichogyne (*t*). Below are the antheridia (*a*) and above an antherozoid (*a'*). C.—An oögonium in same species after fertilization, showing the surrounding pericarp (*p*). D.—The spermocarp liberating its carpospores. E.—Zoöspores formed from the carpospores. (B to E, after Pringsheim.)

* The species is not uncommon in the lakes of Central Europe. I am indebted to Prof. Oltmanns for calling my attention to it on plants of *Isoëtes* in the Titisee, near Freiburg-in-Baden.

defined features in its life history which mark a great step in the evolution of plant life. Firstly, there is the development of the trichogyne. Secondly, there is the influence of the process of fertilization on cells adjacent to the egg-cell, resulting in the formation of a fruit. Thirdly, there is the all-important phenomenon of the division of the carpospore into a group of cells which do not immediately reproduce the parent plant.

We have here, in fact, a very early indication of that *alternation of generations* which has played so important a part in the story of plant life, and a study of which has given us the clue to the relationship between the lower and higher members of the vegetable kingdom. It is here that we see clearly for the first time, in the upward succession of plant types, the distinction between an *oöphyte* or egg-bearing generation and a *sporophyte* or spore-bearing generation, arising from it and in turn reproducing it again.

Some of the consequences of the increasing differentiation of these alternating stages and the specialization of their accessory tissues will be pointed out in later studies.

CLOUD BELTS.

By Wm. Shackleton, F.R.A.S.

ANYONE who has made a voyage beyond the Equator will, no doubt, retain a good recollection of a day or so of disagreeable, oppressive, damp weather, when moisture seemed to be exuding from all sides, just as if one had come out of a dense Scotch mist, and everything was coated with a thick film of moisture which trickled down in great beads. This journey through the watery-laden atmosphere and almost constant rain, is really a passage through the equatorial cloud belt which girdles the planet on which we happen to be located; and although we may admire Jupiter with his many cloud belts as seen through a telescope, yet we feel thankful for the invention of steamships which enable us to leave behind as quickly as possible the most marked cloud-belt appended to our earth, rather than be becalmed in these "doldrums" where ships have been known to drift listlessly about for whole weeks.

A graphic description of the kind of weather which is usually experienced under the cloud ring of the equatorial calm belt is found in the journal of Commodore Sinclair, kept on board the U.S. frigate *Congress* during a cruise to South America in 1817-18. He crossed it in the month of January, 1818, between the parallel of 4° N. and the Equator. He says:—"This is certainly one of the most unpleasant regions on our globe. A dense, close atmosphere except for a few hours after a thunderstorm, during which time torrents of rain fall, when the air becomes a little refreshed; but a hot glowing sun soon heats it again, and but for your awnings and a little air put in circulation by a continual flapping of the ship's sails it would almost be insufferable. No person who has not crossed the region can form an adequate idea of its unpleasant effects. Except when in actual danger of shipwreck, I never spent twelve more disagreeable days than in these calm latitudes."

The general appearance of the sky in this "rainy sea," as it has been called, is a steamy haze—sometimes growing into uniform gloom, with or without heavy rain, at other times gathering into small ill-defined patches of soft cumulus. After dark there is always a great development of sheet lightning till about two in the morning.

The Plate shows the appearance at the edge of the cloud belt on the confines of the south-east trade wind, and is reproduced by the kind permission of Sir J. Benjamin Stone, M.P., from a photograph taken by him in 1894, on his way to South Africa.

Besides this equatorial cloud belt, however, there are two other rings encircling the earth, where rain falls perhaps more incessantly even than in the equatorial belt itself, though by no means in such large quantities. These latter belts occur near latitude 60° in both hemispheres; and perhaps more of us have passed through these than that of the equatorial belt, especially the one crossing the Shetlands and South Norway about Bergen, where it rains nearly every day throughout the year, and which place tourists speak of as especially relaxing, thus experiencing some of the effects described by Commodore Sinclair.

It is not necessary to go into detail as to the actual cause of these cloud belts—that is a matter for text-books; sufficient it is to say that in the case of the equatorial belt, the north-east and south-east trade winds flowing into the equatorial regions to supply the up-draught caused by the intense heating of the atmosphere surrounding the Equator, pass over zones of about twenty degrees in width, from which all, or nearly all, the vapour of evaporation is carried into the comparatively narrow zone of the equatorial calm belt before it ascends to higher and therefore colder levels. In these upper reaches condensation takes place, thereby producing a constant canopy of dense cloud which forms a nearly continuous cloud girdle. The equatorial calm belt, therefore, is also a cloud and rain belt.

It has been estimated that the daily amount of evaporation on the ocean within the tropics is about a quarter of an inch per day. If, then, all this amount of vapour over zones, say, one thousand miles in width on each side, is carried into the calm belt, say three hundred miles in width, and is there precipitated as rain, the daily rainfall would be 1·67 inches; and consequently if this belt were to remain stationary, we should have an annual rainfall of about sixty feet for the average of the width. But since the cloud and rain belt oscillates through a range generally more than twice as great as its width, this amount of rain is distributed in the course of the year over a zone more than three times as wide, and hence in general less than one-third of this amount falls in any one place during the year; *e.g.*, at Maranhão at the mouth of the Amazon, and on the border of the cloud zone, the rainfall is two hundred and seventy inches per year, and is even greater at several places, but this is chiefly due to local influences.

From certain causes the rain and cloud belt, as it exists at any given time, is mostly wider than the belt of calms, but of course neither have very definite limits; these, however, are much better defined over the great oceans, where the trade winds blow much more steadily than on the continents, where regularity is very much interfered with by the various abnormal disturbances of uneven surfaces and mountain ranges, and likewise by the monsoons of the Indian and other oceans. The rain and cloud belt is, however, clearly traceable across the whole of Africa, wherever observations have been made, as also across the American isthmus; but it has greater width and its limits are not so well defined. These cloud zones, on which large amounts of rain fall, are traced out naturally for us on the surface of the globe, and it has been truly said that these regions are the "reservoirs of the great rivers"; *e.g.*, those originating from the equatorial cloud belt being the Amazon, Orinoco, Niger, Nile, and Congo, whilst the Yenesei, Obi, Mackenzie, and St. Lawrence largely derive their supplies from the minor belt in the northern hemisphere.

From certain causes which can be explained, the mean

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THE EQUATORIAL CLOUD-BELT

Off Africa, March 21, 1894. Latitude near Equator, Longitude 10. From a Photograph kindly lent by Sir Benjamin Stone, M.P.

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position of the cloud belt is not coincident with, but lies a few degrees north of, the Equator, and, as has been mentioned before, it oscillates over a zone more than three times its width in a year.

The cause of this annual oscillation of the belt is that during the winter of each hemisphere the earth's surface and atmosphere becomes much colder than it is in the other hemisphere, and consequently the atmospheric volume is considerably less, and there is a pressure gradient above by which the air of the higher strata flows from the warmer hemisphere to the colder, giving rise to a counter flow of air below, from the colder to the warmer hemisphere. The consequence is that the stronger system at this season encroaches somewhat upon the territory of the other, causing the middle of the equatorial calm and rain belt (which is the dividing line between the two systems) to be displaced from its mean position. There is therefore an annual oscillation of the calm and cloud belts, such that the most northerly position is in midsummer and the reverse in midwinter of the northern hemisphere, or, in other words, as the sailors say, "The cloud belt follows the sun."

Wet and dry seasons are thus produced in districts which fall within the range of oscillation of the rain-cloud belt, where it is well defined and not affected by abnormal disturbances, but is somewhat as in the ocean and on level countries. Such is the case with the Orinoco and great Amazonian basin. Humboldt says: "As in the very North the animals become torpid with cold, so here, under the influence of the parching drought, the crocodile and the boa become motionless and fall asleep, deeply buried in the mud. At length, after the drought, the welcome season of rain arrives, and then how suddenly is the scene changed!" In ponds from which, but a week before, the wind blew clouds of sandy dust, the reanimated fish may be seen swimming about, deciduous trees become verdant, and scarcely a week elapses before the plants are covered with the larvæ of butterflies, the forest is murmuring with the hum of insects, and the air is harmonious with the voice of birds.

The rain at these periods excites the astonishment of a European. It descends in almost continuous streams, so close and dense that the level ground, unable to absorb it sufficiently fast, is covered with one uniform sheet of water; and down the sides of declivities it rushes in a volume that wears channels in the surface. In the towns many of the houses are built on raised causeways, so that the roadway is able to act as a river bed during these tropical downpours. Perhaps in some subsequent number of Knowledge we may reproduce a street scene under these conditions, with half-submerged carts, floating barrels, and a rushing stream carrying all before it.

The effects of these alternating seasons can readily be imagined, and to obviate this—or, rather, to have a supply of water for irrigation and other purposes during the dry season—some of the provinces in South America thus affected are constructing large reservoirs; *e.g.*, in the province of Ceará they are damming up the end of a large valley at Quixada, thus forming a large artificial lake in the wet season, which will be distributed gradually over the parched land throughout the *séca*, or dry season.

Space will not here permit me more than to point out that the most conspicuous features of the members of the solar system larger than the earth are their dark belts, whilst in the case of those planets smaller than ours these bands are scarcely traceable. Whether in this respect the earth marks a different condition of things existing on the giant planets to that on the smaller ones (which constitute less than one-hundredth of the planetary mass) is only conjecture; but one would expect that the appearance of the cloud belts on the earth, as seen from some other planet, would, on account of the great reflecting power of clouds and mists, be not in the form of dark but of bands brighter than the general surface.

Seeing, then, that all the large planets are so striated, should we not expect the central and largest body of our system—the sun—to exhibit these characteristics? And, indeed, it does, for are there not two zones of maximum "spotted area" on either side of the equator, along which concentrated portions of cloud belts move across the sun? Hence, if we imagine these gregations of umbræ to be disseminated as penumbræ along the spot zones, we should have presented to us a phenomenon closely resembling that of the "cloud belts" of the larger planets. From these few considerations it may be gathered that "cloud belts" play an important part in the cosmogony of the solar system.

A NEW THEORY OF THE MILKY WAY.

By C. Easton.

TOWARDS the end of a previous article on "Richard A. Proctor's Theory of the Universe" I suggested that, if we confine ourselves to those facts known to-day with sufficient certainty, we can only affirm, with respect to the structure of the Milky Way, that we there see marked irregularity of details, and some traces of a regularity at least partial in the principal features of the phenomenon. Before venturing to go a little further I must sum up the facts and considerations on which this opinion is founded. Want of space compels me in an article of this kind to direct in some cases the reader to the sources of information.

Now that photographs of the Milky Way are so widespread, there is no need to insist on the great irregularity that we observe (in projection) in the distribution of the stars, so long as we confine ourselves to a relatively small portion of the galactic zone. It follows, moreover, from the evidence of all the results recently obtained in the study of the galactic phenomenon, that the manner of distribution of stars *in space* varies, even between limits that are relatively large: in this part of space the stars are widely scattered, in this other part they are gathered together into veritable stellar agglomerations. But, *à priori*, that does not by any means exclude a fairly marked regularity of the Milky Way, *taken as a whole*. Suppose that the Milky Way has the form of the well-known elliptic nebula in Lyra; unless we admit that its borders are defined by this figure, and a perfect regularity of distribution prevails inside this ellipse, we should see—we being situated near the central portion, relatively void of stars—a "Milky Way" enclosing the heavens in a fashion similar to the one we see in reality.

Besides, this theory of a Milky Way roughly annular or elliptical recommends itself by its simplicity, and appears to be the one most widely spread at the present day.

Nevertheless, if one studies the phenomenon closely, there are, in this theory of a galactic ring, several points that require explanation.

We see, it is true, the Milky Way forming a great circle round the heavens, but, even apart from the irregularity of detail, the galactic light is very unequally distributed on the circumference of this ring. The Aquila part is much more brilliant than the Monoceros part. This is not only seen in the studies made with the naked eye, but also in the star gauges; and it is the case for the southern hemisphere as well as for the northern. As for

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the general naked-eye aspect, two minutes' study on a fine evening in September is sufficient to establish the great superiority in brightness of the Milky Way between Sagittarius and Cepheus over that between Cepheus and the Twins. As for the counts and stellar gauges, Sir William Herschel found an average of 161·5 stars in his gauges about Aquila as compared with 82·5 about Monoceros. Celoria found likewise for all stars down to the eleventh magnitude in an equatorial zone of about six degrees breadth, 58·883 stars in the region containing the Milky Way about 18h., and 43·822 in the part that the Milky Way crosses about 6h.* This is a fact that it is quite easy to establish, but whose consequences have not received the attention that they merit.

Unless we admit that we are situated in the centre of the ring, but that in the body of this irregular ring the stars increase systematically, so to speak, towards a point (which is evidently most improbable), we must conclude, as was said above, that the sun in the interior of this hypothetical ring occupies an excentric position, fairly near the side where is Monoceros, moderately distant from Aquila.

But why, then, does the *breadth* of the galactic zone in Monoceros differ so little from that in Aquila? Evidently the Milky Way in general ought to appear larger to us the nearer we approach the hypothetical ring, for we could not presuppose (and before such an utterly improbable thing has been proved independently) that the irregularities in the breadth of the zone (any more than the irregularities of brightness) increase towards a given point in the circumference. But at first sight the Milky Way appears, on the contrary, larger in the region of the Eagle, because of the two brilliant branches, and that is why Kant has already placed the sun near to that part of the Milky Way where this constellation is found. After studying it, however, more attentively with the naked eye, and including all the branches, it appears rather broader on the majority of charts in Monoceros than in Aquila, but the difference is far less than theory would indicate. Is this circumstance due to the mode of formation of the visual Milky Way itself? (See my preceding paper.) No, for in the paper of Prof. Celoria we find an easy way of measuring the breadth of the zone where the stellar density is greater than the "average" ("*physical Galaxy*" †); and it follows from one of his tables—Tavola V—that for the stars as far as the eleventh magnitude (and also for the whole of the fainter stars that W. Herschel saw in his great telescope), the Milky Way is considerably larger in Aquila than in Monoceros, and even (particularly for the relatively brilliant stars 0—11) that the principal branch in the Eagle alone has almost the same breadth as the entire Milky Way in Monoceros, where the galactic light is, moreover, so feeble.

This evidently contradicts the hypothesis of a simple and continuous ring whose parts are all situated at considerable distances from the sun. (Situated in the interior of such a ring, we ought to be able to observe a correlation between the narrow, brilliant, and well-defined portions on one hand, and on the other between the feeble, diffused, and broad portions.) The hypothesis that there is a real duplication of the Milky Way into two branches at the same distance from us, over almost exactly the half of its course, is obviously improbable; but it is also incompatible with the reality, for the classic representation of the "simple" Milky Way* in Cygnus, Monoceros, and Crux, as opposed to the double portion in Crux, Aquila, and Cygnus, does not exist.† If we hold to an annular Milky Way we are compelled to accept at least *two* rings, which both surround us but at very different distances. The nearest ring easily explains the very remarkable circumstance that the fairly brilliant stars—those found in the "Bonn Durchmusterung" of about 0—9·5 magnitudes—are, contrary to the others, more numerous in Monoceros than in Aquila, a phenomenon that is repeated under another form in the belt of bright stars of Sir John Herschel and of Gould.‡ Celoria, moreover, does not hesitate to admit "*due anelli distinti, ne mai interrotti nel loro corso.*" The stars in the nearest ring are projected on the sky following the circle: Cassiopeia, Hyades, Orion, Crux, Scorpius, Ophiuchus, Cepheus, those in the more distant ring following Cassiopeia, Auriga, Monoceros, Crux, Sagittarius, Scutum, Sagitta. The Italian astronomer does not venture an opinion as to whether these two rings really interlace or are only in projection.

At the time when Celoria's researches were published (in 1878), this theory of two *distinct* and *uninterrupted* rings, that appeared to explain fairly well the general features of the galactic phenomenon, did not so much clash as it does to-day with the objection that, presented in this form, it is unacceptable because of the structure of the Milky Way revealed by drawings, and, above all, by photographs. For this reason a single ring (the principal ring, for instance, in Sagittarius and Monoceros) cannot be imagined but by straining probability; as for *two* complete rings, they are quite inadmissible. The phenomenon is evidently much more complicated even in its principal features.

But is this a reason for throwing overboard the *whole* of this theory of Celoria's, which rests, moreover, on serious observations and deductions? By no means. It is not admissible in its entirety, but may well be true in part.

Suppose, for example, that these "rings" of Celoria are not "unbroken," nor even complete rings, but annular detached segments roughly disposed in two planes—or, rather, in a "broken plane" (Struve)—the grave objection that we have just raised ceases to exist, and the system is in accord with the results that Celoria and other astronomers have obtained.

But, first, here are some considerations of a different nature.

If we imagine the Milky Way to be an assemblage of stars and of clusters of stars distributed quite by chance, we ought to find in all regions of the galactic zone the same characteristics very nearly: these characteristics depending on the chance of the projection which should manifest itself sensibly in the same manner in all directions. The details of the distribution will differ greatly in one direction from another, but the general character—the type—will depend only on the general conditions of the whole; the limits between which vary the stellar density, the volume and brightness of the stars in different parts of the system, the frequency of nebulosities and of opaque bodies, etc.—this type will be constant.

In reality it is not so in the Milky Way. Those who have studied it best, both in its aspect to the naked eye

* Sir John Herschel, *Outlines;* F. G. W. Struve, *Etudes;* J. T. Encke, *Astron. Nachrichten*, XXVI., 1848, p. 336; Houzeau, *Uranographie; Atlas*, Mons, 1878; Easton, *Voie Lactée*, 1893; *Astron. Nachrichten*, 3270; Plassmann, *Jahresberichte der V.A.P.*, Berlin, 1893; Celoria, *Pubbl. del Oss. di Brera*, XIII.

† "Le regioni in cui le densità stellari sono più grandi della densità media si possono chiamare regioni lattee." Celoria, *ibid.*, p. 43.

* "Thence" (Cygnus to Perseus, etc.) "the stream is single." Proctor, *Monthly Notices*, XXX., p. 50.

† Boeddicker, *The Milky Way;* Easton, *La Voie Lactée*, etc.

‡ Celoria, *ibid.;* Sir John Herschel, *Outlines;* B. A. Gould, *Uranometria Argentina*, I.

and on photographs, will recognize, I believe, that the *character* of the Milky Way is not the same in Sagittarius and Scorpius, where brilliant and irregular masses—which rather appear to be individually connected with parts of the secondary branch (or with its brilliant stars)—alternate with dark or poor regions; in the region of Andromeda, Lacerta, and about ε Cygni, where an even stream runs parallel to the galactic axis; or in Cassiopeia, Perseus, and Monoceros, where the tendency to duplication has been noticed in some cases independently by Boeddicker, Easton, and Pannekoek; or in the region round Aquila to the west of Altair, where there is arranged a series of fairly bright patches.

A remarkable peculiarity of the general distribution of the galactic light between α and ζ Aquilæ and β Cassiopeiæ is that in the principal (following) branch the brightness decreases *gradually* from the interior border to the exterior, whilst the secondary (preceding) branch is much more uniform. There is only one exception, but that is a curious one: between γ Sagittæ and ν Cygni it is the principal branch that appears dull, whilst a great brilliant patch stretches between β and γ Cygni, on the interior border of the secondary (preceding) branch; it encroaches a little on the dark interspace. A small, very brilliant patch, a little distant, between α and 68 A Cygni, is situated exactly on the galactic axis.

I will only recall here the well-known argument of Sir John Herschel on the dark spaces with well-defined contours in the midst of a luminous zone (Coal-Sack): a similar opening, in connection with a dark, large rift, visible to the naked eye, passing between 68 A and ρ Cygni, is found in a dim part of the zone between α Cygni and α Cephei—first drawn, I believe, by Heis. These two are the chief. The probability is, in fact, very great that we have here veritable holes in a "galactic band or stream," fairly shallow, and fairly remote from us.

We may add that the dark regions which often stretch over large spaces, and which sometimes form veritable intervals between two luminous streams, and occasionally bear the character of fissures in a bed of luminous matter (Mr. Ranyard and Mr. Maunder especially have drawn attention to these curious dark lines in this same magazine*), indicate that in several regions the Milky Way is principally formed by a band or layer, relatively shallow (which does not prevent another band or clusters of stars being possibly projected upon this layer), but fairly extensive in longitude and latitude. Sometimes, as between 74, 68 A, and ρ Cygni, a large fissure crosses the greatest part of the Milky Way in all its breadth. All this does not easily fall in with the theory which only sees in the Milky Way agglomerations, wholly chaotic, of stars and clusters.

The very extensive nebulosities, discovered lately by the aid of photography, which sometimes envelop an entire constellation (Orion, Scorpius), and which are certainly related to the stars, furnish also a valuable argument for the theory that certain extensive parts of the Milky Way are in reality associated, and form each a more or less complete whole.

Thus, I believe, we must come back to this consideration. In detail, the real distribution of the stars in the Milky Way is very irregular. In the grouping of the stellar agglomerations there is manifested, however, in a certain degree, a systematic distribution. This organization of the stellar matter does not, however, go so far as to produce a geometrical figure of any regularity whatever—ring, ellipse, or one or more rings, concentric or interlaced.

The undoubted connection between certain stars, nebulosities, and parts of the Milky Way, overthrows the theory that the Milky Way is infinitely more distant from us than the bright stars. Certain regions of the Milky Way may be relatively near us. It follows from the researches of Celoria that in all probability the Milky Way in Orion is much nearer us than the opposite parts of it. But the same conclusion is arrived at for other portions of the Galaxy. I believe that "Holden's ellipses"*—stars ranged in chaplets, etc.—are not, at least in certain cases, the result of optical illusion (see the magnificent photographs published in KNOWLEDGE, 1891, October and December—the region between α, ξ, and f Cygni), and that the dark fissures sometimes bordered by long ranges of stars, and other phenomena of the same nature, are undoubtedly real. Whatever may be the reason of these strange peculiarities of distribution, it is indeed too difficult to imagine that the regions where they are produced are at incommensurable distances.

Sir John Herschel has already pointed out that the "long lateral offsets which at so many places quit the main stream of the Galaxy, and run out to great distances, are either planes seen edgeways, or the convexities of curved surfaces *viewed tangentially*, rather than cylindrical or columnar excrescences, bristling up obliquely from the general level." ("Outlines," § 792.)

There is nothing, indeed, inadmissible in such trains of stars—veritable branches of the Milky Way—lying across the interior of our stellar system, and, in some cases, coming near our sun. Combining this supposition (which gives a plausible explanation of more than one question) with the theory of "segments of a ring," to which Celoria's theory might be reduced, we find a system of spirals the most simple figure that we can imagine the Milky Way to assume according to this train of thought.

As an analogy from what we see in the heavens, I will take, not the nebula of Lyra, but rather the nebula Mess. 101 Ursæ Maj. (Roberts, "A Selection of Photographs," 1894, p. 32; also KNOWLEDGE, February, 1897, p. 54, Fig. 2), or else the celebrated spiral nebula in Canes Venatici, Mess. 51 Can. Venat. (Roberts, *ibid.*, p. 30; and KNOWLEDGE, February, 1897, p. 54, Fig. 4).

This analogy also leads us to seek for a central nucleus towards which the spirals may be directed. Now there is one region in the Milky Way which, it indeed appears, may occupy such a position.

In discussing Celoria's theory we have seen that, to explain the more general traits of the galactic problem, we might place the sun excentrically in one great ring (nearer to the Monoceros border), and inside a smaller ring. As the points of intersection of these two hypothetical rings, inclined to each other at about nineteen degrees, are distant from each other in the heavens about one hundred and eighty degrees (Crux—Cassiopeia), it was better to imagine the inner ring as fairly small. On the other hand, the sun ought to be near that part of this small ring which is in the direction of Monoceros, since this region is fairly well resolved into separate stars (see my preceding article). If Celoria had made his counts, not along the equator, but at about thirty-five degrees, he would have found that this secondary "ring," very dim in general, has one brilliant portion in Cygnus; and this portion, opposite to that region to which our sun is nearest, is situated (in the smaller ring) *at the middle of the system.*

* *See* KNOWLEDGE, 1891, October, December; 1892, May; 1893, April; 1894, October; 1895, January, February, August, November; 1896, February.

* Holden, *Publications Washburn Observatory*, II.

XUM

Besides, the part of the Milky Way in Cygnus is remarkable from more than one point of view. The luminous spot $\beta-\gamma$ Cygni is the *only* luminous patch situated in the "secondary branch," but near the dark space. It is an exception to the manner of distribution of brightness over the breadth of the Milky Way, between the Eagle and Cassiopeia. It is evidently connected with several other very brilliant regions (the spots α—A, $\rho-\pi$ Cygni, etc., perhaps to the series of spots west of Altair). There are in the Milky Way other more luminous spots, but they are much smaller. Sir William Herschel here found his maximum gauge (588 stars in a telescopic field of 15′·4). Not far from here, Kapteyn* placed the centre of the agglomeration of bright stars in the neighbourhood of the sun. Without wishing to dogmatize, it is here that I would place the central condensation of a galactic spiral; the sun is thus found between this central nucleus and the spirals directed towards Monoceros, in a region relatively sparse. As to giving a rather more definite form to such a spiral, it is a research that I have sometimes attempted, but it would be premature to give the result here; moreover, many kinds of spirals are in accord with the theory.

For want of space many considerations could not be presented or only glanced at. In concluding, I wish to insist that this theory does not pretend to give an explanation of all the facts that are grouped about a phenomenon so complicated as the Milky Way, but that it is to be taken above all as a "working hypothesis."

ERRATA.—In my article in the January Number, 1898, of KNOWLEDGE, p. 12, line 24, read: "Sir John Herschel has *not* stated," etc.; p. 13, line 15, read: "these points have *not* been raised," etc.

It would be just to add that the admirable photographs of the Milky Way by Pickering have appeared after my first article was written.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

VARIABLE STARS.

To the Editors of KNOWLEDGE.

SIRS,—Since my note of July 28th, KNOWLEDGE, October, 1897, I have seventy-five observations of R Scuti, making in all one hundred and forty-eight up to the close of the season, when the star passed westwards. Each of these observations is the mean of two to five views.

As heretofore stated, neither Chandler or "The Companion" gave data for this star in 1897, but, following their computations of previous years, the computed and observed dates of the extreme phases of the star are as follows:—

		Maxima.			Minima.		
		C.	O.	Mag.	C.	O.	Mag.
1896.	May	6	—	—	—	6	10
	June	—	11	5·1	11	29	6·2
	July	16	17	5·4	—	31	6·2
	August ...	—	13	5·8	21	—	—
	September ...	25	—	—	—	21	8·5
	October ...	—	—	—	31	—	—
	November ...	—	7	5·6	—	17	5·8
	December ...	5	—	—	—	—	—

* Kapteyn, *Verslagen Kon. Akademie v. Wetensch. te Amsterdam*, 1892, 1893.

From July 31st to September 21st the fall (excepting some small fluctuations) was steady, and was followed by a rise of similar character until November 6th, when it began to fall again, making probably another reversal like those of May 6th and September 21st. The latest observation of the star was November 17th.

From 1896, December 29th—the computed date of maximum of R Leonis that year, as given by "The Companion—another maximum was due in 1897, November 7th; but the same authority, and Chandler, give the date as October 8th, which is apparently a correction of thirty days; but the star, on its last rise, appeared so near daybreak that observations were inconvenient. It fell in with my habits, however, and as soon as it rose above the horizon before day, I gave it attention, and submit the following data, which covers the means of twenty observations, but only the changes are given:—

			Mag.				Mag.
1897.	October	4	6·7	1897. November	3		7·1
	,,	6	6·4	,,	4		7·2
	,,	12	6·3	,,	6		7·3
	,,	13	6·2	,,	11		7·4
	,,	17	6·1	,,	15		7·5
	,,	21	6·0	,,	23		7·6
	,,	24	6·3	,,	29		8·0
	,,	26	6·6	December	6		8·3
	,,	30	6·9				

A maximum on October 20th is indicated, but some other observers may be able to show that one occurred earlier. It is to be hoped that someone has seen the star in September.

o Ceti (Mira) has been at a stand for some days, nearly on a level with 66 and 70, or at 5·5 magnitude.

I found S S Cygni at a maximum January 17th, at 8·5 magnitude, unchanged on 22nd, and a step or two fainter on 25th. On 26th, the seeing being very poor, the star was hardly visible. The period on this appearance was forty-three days, the previous one being sixty days, and it seems to have remained at maximum longer this time than heretofore.

Cloudiness has been the rule throughout the States at nights for some time; the mornings are more favourable, but are hazy and damp.

DAVID FLANERY.

Memphis, Tenn., U.S.A.,
28th January, 1898.

THE DRAPER CATALOGUE.

To the Editors of KNOWLEDGE.

SIRS,—Mr. Maunder has made a mistake in his article in your February Number in describing the Draper Catalogue as a complete catalogue of the spectra of stars down to the eighth magnitude. This is certainly incorrect. But one drawback to this catalogue (as well as to many other catalogues) is that we do not know the point down to which it is complete, and are, consequently, liable to err in applying its results to star distribution generally. The Draper Catalogue is not complete up to the fifth magnitude. For instance, it does not contain the star 3 Aquarii, measured 4·62 in the *Harvard Photometry*, and 4·84 at Oxford. Between the fifth and sixth magnitudes the omissions are pretty numerous; for example, 36 Aquilæ, measured 5·23 in both the Oxford and Harvard Catalogues. The *Harvard Photometry* contains some stars lying farther south than any in the Draper Catalogue, but the latter does not contain thirty or forty of those measured at Oxford as under the sixth magnitude. 56 Pegasi is another instance in which the omitted star is brighter than the fifth magnitude. I am not writing for the purpose of

discrediting the catalogue, but in the hope that Prof. Pickering may publish a supplement correcting any errors in it that have since been detected, and making it complete up to, say, magnitude 6·5. According to his present views, moreover, the kinds of spectra enumerated would, I believe, be less numerous, E and H practically disappearing. In his late list of the spectra of bright southern stars in the *Astrophysical Journal* the varieties of spectra are indicated (when not exactly corresponding with a given type) by the two types between which they lie, with a figure indicating the position between them. Thus A 5 F indicates a spectrum just halfway between A and F (the estimate being made in tenths), while A 4 F indicates that it is somewhat nearer to A than to F, and A 1 F is very nearly equivalent to A. This kind of designation will be found more convenient to those who are well acquainted with the Draper Catalogue than the more elaborate classification of Miss Maury.

W. H. S. MONCK.

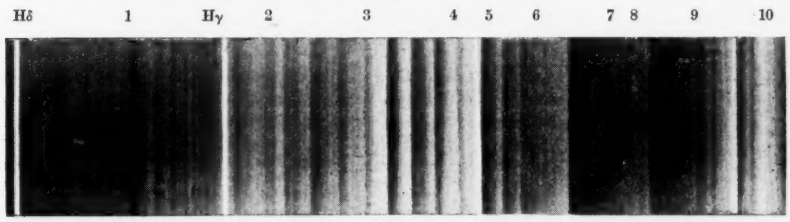
SPECTRUM OF *o* CETI.

To the Editors of KNOWLEDGE.

SIRS,—The reproduction of the spectrum of *o* Ceti is a ninefold enlargement from a negative obtained on November 29th, on an Edwards isochromatic plate, with a small direct compound prism near the focal plane of the fifteen-inch objective. Extra breadth has been given to the enlargement by a cylindrical lens. All the fine lines in the picture have been verified by comparison with the negative, which shows also many details lost in the enlargement. Some of the lines and edges of bands are numbered for reference to the following table of wave lengths :—

1	4227	4	4757	7	5162
2	4421	5	4842	8	5237
3	4580	6	4950	9	5445
				10	5755

The banded spectrum is the same, in general, as that of



Photographed Spectrum of *o* Ceti.

α Herculis and stars of this class, the minor differences of which are under examination at present.

The characteristic of the spectrum of *o* Ceti is its hydrogen radiation. The two brilliant lines H_δ and H_γ have lost nothing during the last seven weeks. The missing lines H_ϵ and H_β would both be well marked on the plate if their radiations arrived. Of the former there is no trace on any of the plates. Of the latter there may be a feeble representative : there is a weak division of the absorption band on the red side of No. 5, at the position of H_β, and this may be a remnant of H_β light unabsorbed by the superposed origin of the dark band.

Smaller photographs of the spectrum, by a half prism and short focus camera lens, show the bright hydrogen lines γ, δ, ζ, and η, with the dark calcium bands at H and K. The hydrogen spectrum is therefore substantially the same now as it appears on a copy of a Harvard College photograph taken some time previous to the spring of 1892, which, by the kindness of the Rev. Espin, is in the possession of the observatory ; but probably the lines δ and γ are much brighter now, while β cannot be compared, this region not being included in the copy of the Harvard photograph.

There appears to have been a progressive change during the last seven weeks in the relative intensities of parts of the continuous spectrum. The maximum brightness in the accompanying photograph is between the numbers three and four. On December 11th the brightest parts are the two columns near No. 9, and on December 19th this change is still more pronounced.

WALTER SIDGREAVES, S.J.

Stonyhurst College Observatory,
8th January, 1898.

ERRATA IN TIMES OF ECLIPSES OF THE MOON.

To the Editors of KNOWLEDGE.

SIRS,—I expected you would have noticed in February Number the erroneous times given for the moon's eclipse in January Number, but I do not observe any correction.

Any great mistake in the *Nautical Almanac* is so unusual that it is not wonderful it should appear in other publications ; but as all the eclipses of the moon for this year are wrong in the *Nautical Almanac* for 1898, it is of importance that it should be known. The errata are given in *Nautical Almanac* for 1899, and the true values are given in *Whitaker's Almanack*, the nearest second ; but so many almanacks have been more or less caught that you will pardon me for sending you a line. LEWIS HENSLEY.

Hitchin Vicarage,
February 22nd, 1898.

"LIQUID FLUORINE."

To the Editors of KNOWLEDGE.

SIRS,—In the article on "Fluorine" there is an expression made use of which, I think, requires some explanation. It is—"absolute zero, where, if our present knowledge is of any worth, the life of the universe itself would be extinguished."

What is the life here meant ? Of course a much less minus temperature than −210° would extinguish all animal life on any planet ; the "life of the universe" must be something else.

S. H. WRIGHT.

3, Cator Road,
Sydenham, S.E.,
2nd February, 1898.

[In writing of a particle of matter, its energy of motion —that is to say, its heat—may be considered as the vitality of the particle. When we speak of "live steam," for instance, we mean steam at a high temperature and pressure. Now, a gas expands by $\frac{1}{273}$rd of its volume (at 0° C. and 760 min. bar. pressure) for every degree Centigrade through which the temperature is raised, and if the temperature be lowered by one degree it contracts by that amount ; so that "absolute zero" is the point where the gas has contracted theoretically to nothing, namely, − 273° C. At this point a gas has no volume and no pressure, and may be considered as dead. This is what I meant when I said that at absolute zero the life of the universe itself would be extinguished.—C. F. TOWNSEND.]

THE MASSES AND DISTANCES OF BINARY STARS.

By J. E. Gore, F.R.A.S.

In a valuable and interesting volume recently published by Doctor See, of the Lowell Observatory, Mexico, he gives a recomputation of the orbits of forty of the best known binary systems. Some of his results —all of which are based on a careful consideration of the best recorded measures—do not differ widely from those of other computors. In other cases, however, his orbits differ considerably from those previously published; and as he has included very recent measures in his discussions, his results are probably more accurate than any hitherto published. In the following table I give the period (P) and the semi-axis major (a) of the orbits found by Dr. See. From these I have computed the hypothetical parallax, $p=\frac{a}{P^{\frac{2}{3}}}$, or the parallax of the star on the assumption that the mass of the system is equal to the sun's mass. To these I have added the magnitudes of the stars which have been photometrically determined at Harvard, and the character of the star's spectrum, I. being the Sirian and II. the solar type.

Star.	Period. Years.	Semi-Axis Major.	Hypothetical Parallax.	Mag.	Spectrum.	Remarks.
		Secs.	Secs.			
Struve 3062 ...	104·61	1·3712	0·061	...	II.	
η Cassiopeiæ	195·76	8·2128	0·243	3·64	II.	
γ Andromedæ	54·0	0·3705	0·026	(5)	...	Magnitude estimated.
Sirius... ...	52·20	8·0316	0·575	+1·43	I.	
9 Argûs ...	22·00	0·6549	0·083	5·49	...	
ζ Cancri ...	60·0	0·8579	0·056	4·72	II.	
Struve 3121 ...	34·00	0·6692	0·063	...	II.	
ω Leonis ...	116·20	0·88241	0·037	5·55	II.	
φ Ursæ Maj.	97·0	0·3440	0·016	4·43	I.	
ξ Ursæ Maj.	60·00	2·508	0·163	3·80	II.	
O Σ 234 ...	77·0	0·3467	0·019	...	II.	
O Σ 235 ...	80·0	0·8690	0·047	5·56	II.	
γ Centauri ...	88·0	1·0232	0·051	2·36	I.	
γ Virginis ...	194·0	3·989	0·119	2·84	II.	
42 Comæ ...	25·556	0·6416	0·074	4·38	II.	
O Σ 269 ...	48·8	0·3248	0·024	...	...	
25 Can. Venat.	184·0	1·1307	0·035	5·00	I.	
α Centauri ...	81·10	17·70	0·944	0·20	II.	
O Σ 285 ...	76·67	0·3975	0·022	...	...	
ξ Boötis ...	128·0	5·5578	0·218	4·60	II.	
η Cor. Bor. ...	41·60	0·9165	0·076	4·98	II.	
μ^2 Boötis ...	219·42	1·2679	0·034	(6·5)	I.	Magnitude estimated.
O Σ 298 ...	52·0	0·7989	0·057	...	II.	
γ Cor. Bor. ...	73·0	0·7357	0·042	4·18	I.	
ξ Scorpii ...	104·0	1·3612	0·061	4·10	II.	
σ Cor. Bor. ...	370·0	3·8187	0·074	5·29	II.	
ζ Herculis ...	35·00	1·4321	0·134	3·09	II.	
β 416	33·0	1·2212	0·118	5·85	...	
Σ 2173 ...	46·0	1·1428	0·089	...	II.	
μ^1 Herculis...	45·0	1·390	0·110	(9·4)	...	Estimated Magnitude.
τ Ophiuchi ...	230·0	1·2495	0·033	4·93	II.	
70 Ophiuchi...	88·3954	4·548	0·229	4·11	II.	Computed mass of system equals 6·368 times sun's mass.
99 Herculis ...	54·5	1·014	0·070	5·36	II.	Mass of system equals sun's mass.
ζ Sagittarii ...	18·85	0·686	0·097	2·89	I.	Star 1·75 magnitude brighter than sun.
γ Cor. Aust.	152·7	2·453	0·085	4·28	II.	
β Delphini ...	27·66	0·6724	0·073	3·74	I.	
4 Aquarii ...	129·0	0·732	0·028	...	II.	
δ Equulii ...	11·45	0·452	0·089	4·60	II.	
κ Pegasi ...	11·42	0·4216	0·083	4·21	II.	
85 Pegasi ...	24·0	0·8904	0·107	5·83	II.	
β 883	5·5	0·621	0·1993	(7·8)	...	Estimated magnitude.

Now, if we take the sun's stellar magnitude as −27: that is, twenty-seven magnitudes below the zero magnitude (see my paper in Knowledge for June, 1895): and compute what its magnitude would be if removed to the distance indicated by the "hypothetical parallax," we find that in most cases the binary star is brighter than the sun would be if placed at this distance. It follows that to make the sun of equal brightness with the star it should be placed at a less distance than that indicated by the "hypothetical parallax"—that is, the parallax of the binary star should be increased. This would have the effect of diminishing the mass of the system, as I showed in a former paper. (Knowledge, December, 1894.) Now if B represents the number of times which the star exceeds the sun in brightness when both are placed at the distance indicated by the "hypothetical parallax," and s represents the increased parallax, we have $s=p\sqrt{B}=\frac{a\sqrt{B}}{P^{\frac{2}{3}}}$ Again, if m and m_1 represent the masses of the components of the binary system, and $m+m_1=n\mathrm{M}$, where M is the mass of the sun, we have, taking $\mathrm{M}=1$, $n=\frac{a^3}{p^3P^2}$, and for the parallax, s, $n=\frac{a^3}{s^3P^2}$, or, substituting the value of s found above, and reducing, we have $n=\frac{1}{B^{\frac{3}{2}}}$. To find B we have (sun's mag.−star's mag.)×0·4 = log. B.

Let us now consider some of the most remarkable cases in the above list which have spectra of the solar type. I omit those in which the difference of magnitude between the sun and star does not exceed one and a half magnitude, or about four times.

ξ Boötis. In this case the sun would be reduced to a star of 2·88 magnitude, which gives a difference of 1·72 magnitude in favour of the *sun*. This would make the sun 4·875 times brighter than the star at equal distances. The parallax must therefore be diminished, and hence the mass of the system would be $B^{\frac{3}{2}}=10{\cdot}77$ times the mass of the sun.

ξ Scorpii. Here the sun would be reduced to magnitude 5·64, giving a difference of 1·54 magnitude in favour of the *star*. Hence the mass of the system would be $\frac{1}{8{\cdot}395}$ of the sun's mass. The spectrum is a doubtful one of the second type (F ?).

τ Ophiuchi. In this case the sun would be reduced to magnitude 6·98, if placed at the distance indicated by the "hypothetical parallax," and, the star's photometrical magnitude being 4·93, there is a difference of 2·05 magnitudes in favour of the star. Hence B = 6·607, and $n=\frac{1}{17}$, or the mass of the system would be one-seventeenth of the sun's mass, and the star's parallax about 0·085″. The spectrum is of the solar type.

In the case of 99 Herculis the sun would be reduced to magnitude 5·34, or almost exactly equal to the star in brightness, and, the spectrum being of the solar type, the mass of the system is probably equal to the mass of the sun. The companion is very faint and of a purple colour, and may possibly be approaching the planetary stage of its history.

α Centauri is a very interesting case. Here the sun would be reduced to a star of magnitude −0·31, or 0·31 magnitude brighter than a star of zero magnitude; and as the star's photometric magnitude is 0·20, we have a difference of 0·51 magnitude in favour of the sun, or $B=\frac{1}{1{\cdot}6}$. Hence the parallax would be reduced to $\frac{0{\cdot}944}{\sqrt{1{\cdot}6}}=0{\cdot}746''$, and the mass of the system would be 2·023 times the sun's mass. As Dr. Gill found a parallax of 0·75″, and Dr. See computes from his orbit a mass of 2·00, the mass of the sun, it would seem that the orbit, parallax, and photometric magnitude of this remarkable star have been correctly determined.

With reference to the binary stars having the Sirian type of spectrum, let us consider the case of Sirius itself. If the spectrum of Sirius were of the solar type and strictly comparable with the sun, I find that its parallax would be about 1·58″, and its mass about one twenty-first part of

the sun's mass. But Dr. Gill found a parallax of 0·38″, and Dr. See computes from his own orbit and this parallax that the mass of the system is 3·473 times the mass of the sun.* Now I find that if the sun were placed at the distance indicated by Dr. Gill's parallax it would be reduced to a star of 1·67 magnitude, or 3·10 magnitudes fainter than Sirius. This implies that Sirius is 17·38 times brighter than the sun would be at the same distance. But if Sirius were of the same density and intrinsic brightness as the sun, its mass would imply that it should be only 1·773 $(2·36)^{\frac{1}{3}}$* brighter than the sun. Hence we see that Sirius is nearly ten times brighter than it would be had it the same density and brightness of surface as the sun has. Hence, as Dr. See says, "there is some reason to suppose that *Sirius* is very much expanded, more nearly resembling a nebula than the sun."

ϕ Ursæ Majoris is a very brilliant star. Here we have the sun reduced to a star of 8·55 magnitude, or a difference of 4·12 magnitudes in favour of the star. Hence B=44·47 and $n=\frac{1}{2\,0\,6}$. The spectrum is of the Sirian type. For γ Cor. Bor., I find B = 8·091 and $n=\frac{1}{2\,5}$. γ Centauri is another brilliant star. Here B = 29·38 and $n=\frac{1}{1\,5\,0}$.

There are two remarkable cases in which the sun, if placed at the distance indicated by the "hypothetical parallax," would be considerably *brighter* than the binary star. One of these, μ^1 Herculis, is referred to in a former paper (KNOWLEDGE, December, 1894). Here, the sun would be reduced to 4·36 magnitude, and, taking the star's magnitude as 9·4, we have a difference of about five magnitudes in favour of the *sun*. This would *reduce* the star's parallax to 0·011″, and would make its mass no less than one thousand times the mass of the sun! The star being so faint its spectrum has not been determined, but it forms a distant companion to μ^2 Herculis, the magnitude of which was measured 3·49 at Harvard, or nearly one magnitude brighter than the sun would be if placed at the "hypothetical" distance. If we increase its distance ten times, as indicated by the above calculation, we must conclude that μ^2 Herculis is no less than two hundred and twenty-three times the brightness of the sun! According to the Draper Catalogue the brighter star has a doubtful spectrum of the solar type (Class II.?). As both stars have a common proper motion, they probably lie at practically the same distance from the earth, and the only explanation of the above startling results seems to be that the binary star has—like the companion to Sirius—cooled down, and is, therefore, not comparable in its physical constitution with the sun.

Another remarkable case is that of β 883—a binary of very short period, whose rapidity of motion has recently been discovered by Dr. See. Here the difference of brightness is about four magnitudes in favour of the sun, which would make the mass of the system about two hundred and fifty-one times the sun's mass! But here again we do not know the character of its spectrum, so cannot say whether the star is really comparable with the sun in brightness.

WE understand that Mr. Thomas H. Blakesley, M.A., C.E., the well-known instructor in physics and mathematics at the Royal Naval College, Greenwich, has resigned his seat at the Council Board of the Physical Society of London. Mr. Blakesley is, therefore, no longer Honorary Secretary of that learned body.

* The mass of the bright star is 2·36 times the mass of the sun. The mass of the companion, which is very faint (and does not affect the brightness of the primary), is, according to Dr. See, 1·113 times the sun's mass.

Science Notes.

H.R.H. the Prince of Wales has graciously consented to open the International Photographic Exhibition at the Crystal Palace. Intending exhibitors are asked to note that the date of opening of the Exhibition by His Royal Highness has been fixed by him for Monday, April 25th, and not Wednesday, April 27th, as originally announced. The latest date for the reception of exhibits in each section will therefore be two days earlier than that first stated on the prospectus.

The number of applications for patents during the year 1897 was thirty thousand nine hundred and thirty-six, as compared with thirty thousand one hundred and ninety-four in 1896 and twenty-five thousand and sixty-five in 1895. Although the number of patents applied for illustrates the progress of inventive activity, it does not afford any reliable criterion as to the number which arrive at maturity. Out of the thirty thousand one hundred and ninety-four in 1896, for example, only thirteen thousand three hundred and sixty were completed, the rest being allowed to lapse after the nine months' protection. Not a few of the applicants for patents are women, of whom there were about seven hundred in 1896; some hundred and fifty of these inventions relating to dress.

A new bibliography of great value to scientists is now being prepared of all the technical works in that unique and most easily accessible collection, the Patent Office Library, and will be completed in two volumes. In the first volume the books and pamphlets, etc., will be indexed under the names of authors, and the second volume will be a subject-matter index. A proof, including the letters A, B, C, D, consisting of two hundred and forty pages of the first volume, has been placed in the Library for the use of the public.

Notices of Books.

The New Psychology. By Dr. E. W. Scripture. Illustrated. (Walter Scott.) 6s. By such a book as this, belonging to the Contemporary Science Series, psychology is lifted out of the arena of abstract philosophy and established upon the sound basis of experimental science. The development of the new or experimental psychology within the last few years has produced a large amount of remarkable material which has remained almost unknown except to specialists. Most of this work has been done in Germany and the United States, and Dr. Scripture is one of the foremost of the workers. What a vast amount of material has been accumulated may be seen by reference to the "Psychological Index," or those two excellent journals the *Psychological Review* and the *Journal of Psychology*—the like of which do not exist in this country. Perhaps, now that a psychological department has been established at University College, we may also be able to give similar hostages to fortune. The fact is that many men of science in this country are disinclined to give psychology a *locus standi*: the chemist and physicist look upon it as akin to metaphysics, and the physiologist regards it as a presumptuous sub-department of his branch of natural knowledge. It is not clear why physiologists generally do not look with eyes of favour upon this younger science, for surely it is immaterial what designation is given to any department of scientific work so long as facts are being accumulated. Moreover, the barriers between the various sciences are being broken down daily. The methods and

results of physical science (using the term in its widest sense) are being used to assist the progress of the natural sciences; and the new psychology is a valuable product of this combination.

Dr. Scripture's volume contains a clear statement of the chief work that has been done on what may be termed the connection between thought and action. It is not concerned with the academic distinctions between sensation and perception, and similar discussions of ideas, but treats of mental life in relation to time, energy, and space, and shows how physical instruments may be used to measure these relationships. The book is in itself a justification of the claims of psychology to a place among experimental sciences.

Natural Causes and Supernatural Seemings. By Henry Maudsley, M.D. Third Edition. (Kegan Paul.) Dr. Maudsley's book is neatly, if not completely, epitomized in its title. Presentiments, imprecations, magic incantations, predictions of witchcraft, omens, hallucinations, and all phenomena usually ascribed to the supernatural, are here sternly confronted with the unsympathetic conclusions drawn by cool reason from cause and effect. The multitude will always take its opinions from custom and tradition, and on the authority of others; but there are not a few who agree with Voltaire when he said that "magic words are capable of destroying a whole flock of sheep—if the incantation be accompanied with a sufficient dose of arsenic." The author looks upon life as an intensely real thing, and apparently regards the whole of our existence as a sort of complex mosaic, the intrinsic beauty of which is masked by the creations of unbridled imagination. It is plausible but quite false presumption that mankind in general act on rational principles: the masses, being mainly foolish, have always held to the wrong opinion until dragged out of it by the labours of the few who differed; and there is probably much truth in Dr. Maudsley's assertion that "the extinction of a few hundred persons in a generation, who keep the torch of knowledge burning in Christendom, would bring progress to a standstill, and might throw the world back into intellectual barbarism in the course of two or three generations; all the more easily because, besides the passive resistance of a dead weight of ignorance, there is a vast and powerful organization of hostile superstition watching and working to stop intellectual progress." In short, the volume affords us a glimpse into the mighty edifice of error built on the basis of defective observation; and, abandoning the preposterous plane of speculative intuitions, we have presented before us images in the unassuming habiliments of sense and reason. Still, as the senses are only so many narrow chinks of experience between two unknown infinities—the infinitely great and the infinitely small—there is a danger of oscillating from the warm equatorial regions of imagination to the extreme polar climes of frigid logical deduction.

By Roadside and River. By H. Mead Briggs. (Elliot Stock.) 3s. 6d. Richard Jefferies has had of late many imitators. For some years past the public has been liberally supplied with a class of book of which "By Roadside and River" is an example. The authors, without laying claim to scientific accuracy, display, as a rule, some powers of observation, and Mr. Mead Briggs is no exception. The one thing necessary to make such a book readable, however, is a fair command of literary English, and the power of recording the author's observations and meditations (if we must have these meditations) in language which is intelligible. But it is in those very points that Mr. Mead Briggs comes lamentably to grief. It is scarcely an exaggeration to say that in every page of "By Roadside and River" the reader is irritated and perplexed by some atrocious solecism, some wanton dislocation of a trite expression, even if he escape the puerile essays in metre with which the book is plentifully studded. Passing by with a shudder such combinations as "child and blandlike" (applied to a bird which "ventures to speak in a shrilly voice"), we are pulled up short by the following reflection: "But accident and misfortune appearing suddenly upon our best bright days, comes [*sic*] as a thief in the night to take our happiness, and leaves our senses numbed." The swallow is depicted as "reflecting her dainty form in the mirrored stream." When Mr. Briggs descends from reminiscence and moralization to a record of facts, he has much that is interesting, if little that is new, to tell us. His observations of nature are, in the main, just, though we believe naturalists are agreed that the cuckoo's method of depositing her egg in the nests of other birds is by the beak, and not by the claw; and also that the eyes of the mole are practically useless, and that this creature cannot "see with ease in the dark caverns of the earth."

Wild Traits in Tame Animals, being some Familiar Studies in Evolution. By Louis Robinson, M.D. (Blackwood.) Illustrated. 10s. 6d. net. This is a very readable book for several reasons. It is well written; it deals with simple everyday matters. The theories and suggestions it contains are plausible, and, above all, it teaches the reader to think. The plan of the book is to discuss familiar traits in tame animals such as dogs, horses, cats, etc., to compare these traits with those of wild animals, and to seek to trace their origin and explain their significance. The author succeeds fairly well, but, as would be expected, he occasionally pushes an analogy or a theory too far, and there is a paucity of facts throughout. Some of the suggestions and hints for study and research are valuable. If there is not much that is actually new in the book, there are many things which are put in a new and generally attractive light. Altogether, it is a book which should be read by every naturalist, and parts of it could, with profit, be read more than once. It will prove very valuable to the young student, providing he reads it slowly, and, thinking for himself, sifts the evidence, takes nothing for granted, and, above all, compares it with the greatest book of all—the book of nature.

Montaigne and Shakspere. By John M. Robertson. (The University Press, Limited.) 5s. net. The debt of genius to its forbears must always be considerable, for human experience is so "cabin'd, cribb'd, confin'd," that even Shakspere could only write upon what he had himself observed, heard, or read. That he was familiar with Florio's rendering of Montaigne has long been unquestioned, but the precise degree in which he was influenced by the great essayist will always form material for interesting if not altogether profitable inquiry. In this handsomely printed and elegantly mounted volume, Mr. John M. Robertson has brought his critical acumen to bear upon the problem, which he discusses throughout with a refreshing freedom from that venomous antipathy which so often disfigures these analytical examinations of the work of the immortals. "We are embarked," he says, "not on a quest for plagiarisms, but on a study of the growth of a wonderful mind. And in the idea that much of the growth is traceable to the fertilizing contact of a foreign intelligence, there can be nothing but interest and attraction for those who have mastered the primary sociological truth that such contacts of cultures are the very life of civilization."

In this eminently fair introduction to the study of the comparisons will be found the key to Mr. Robertson's

work; and if he has claimed more for his thesis than the occasional identity of thought and similarity of expression will fairly carry, still he has not for an instant wavered in his allegiance to the study on which he set out. But he appears to contradict himself upon the important question as to whether Shakspere had seen parts of Florio's translation earlier than 1603—the year of its publication—"or even that he might have read Montaigne in the original" (page 12); for later on in the essay (page 50) Mr. Robertson says: "That Shakspere read Montaigne in the original once seemed probable to me, as to others; but on closer study I consider it unlikely, were it only because the Montaigne influence begins in Hamlet." In that case, of course, at least one of Mr. Robertson's parallelisms falls to the ground.

That Montaigne lighted a lamp in Shakspere which shone through all his after work is clear, but the quaint old French philosopher's searching criticisms of life were given an immortal setting by the poetic genius of the English dramatist. "The influence," says Mr. Robertson, "is from the very start of that high sort in which he that takes becomes co-thinker with him that gives, Shakspere's absorption of Montaigne being as vital as Montaigne's own assimilation of the thoughts of his classics. The process is one not of surface reflection, but of kindling by contact; and we seem to see even the vibration of the style passing from one intelligence to the other, the nervous and copious speech of Montaigne awakening Shakspere to a new sense of power over rhythm and poignant phrase, at the same time that the stimulus of the thought gives him a new confidence in the validity of his own reflections."

The subject is a fascinating one indeed, and not alone to the student of Shakspere, for Mr. Robertson's critical method is so unemotional and impassive, and yet so scrupulously just and many sided, as to afford in itself an interesting and instructive study, quite apart from the special interest of its subject.

The Elements of Astronomy. By Chas. A. Young, Ph.D. (Ginn & Co.) Illustrated. This edition of Prof. Young's book has been revised and brought up to date. The author is well known by his larger work—"General Astronomy"; but it is asserted that the volume under notice is not a mere compilation from the more pretentious work. Its purpose is to teach astronomical science to scholars in middle-class schools, and more especially those who have not much mathematical knowledge beyond the limits of simple algebraic and trigonometrical functions. Indeed, the science of astronomy may be made interesting without any knowledge at all of formulæ. The book, we think, fills the requirements of the class of students specified. All the latest researches are mentioned, including the eclipse of the sun in August, 1896, and genuine additions to our knowledge are incorporated. Clear descriptions are given of the planets, stars, nebulæ, etc.—and by *clear*, we mean that the author here exhibits the happy knack of conveying information, even on intricate subjects, in language shorn of all pedantry: an acquisition, or a gift—it is difficult to say which—not by any means common among scientific men of the first rank. A little pamphlet, called a uranography, is tacked on, which was at first intended to be issued separately; it is meant as an open-air guide to a study of the principal stars, and is accompanied by charts representing the chief constellations. A good feature of the whole book consists in the free distribution of a large number of first-rate diagrams, which add not a little to the general attractiveness of the volume—a great desideratum in text-books. A synopsis and questions are added for the benefit of those who read the book for examination purposes.

SHORT NOTICES.

The Machinery of the Universe. "Romance of Science" Series. By A. E. Dolbear. (Society for Promoting Christian Knowledge.) Illustrated. An ambitious title, truly! and also misleading. "The machinery of the universe" turns out to be that mysterious ether which, if occasion requires, can perform either the functions of a fluid or a solid, or do duty for *both* at one and the same time. Writing of the number of molecules in the visible universe, the author says (page 29): "The point is that there is a definite, computable number." A definite number there may be, but *computable*, never. As well might one say that all the thoughts which have ever entered the myriads of human heads are computable. Although the author displays much erudition, he has not yet learnt to take off his shoes, and to cover himself with sackcloth and ashes, when entering the inner court of the great unknown.

Chemistry for Photographers. By C. F. Townsend. (Dawbarn & Ward.) Illustrated. 1s. net. There is much in this book of use to the practical amateur photographer who wishes to understand the nature of the various chemicals he has to use. There are brief but ample explanations of such mysteries as the salts of silver and development; also useful chapters on the different printing processes, impurities in acids and alkalis, and a number of hints on miscellaneous subjects connected with the art of photography.

Pictorial Instruction Object Lessons. By G. Colomb. Adapted into English by Seymour J. Gubb, B A. (Relfe Bros.) Illustrated. 1s. 6d. Akin to that popular French scientific book of Paul Bert's, the idea of M. Colomb is to combine in his book pictorial illustration with instruction in a manner suitable to be put into the hands of the younger generation. It is, in fact, a kind of child's picture book, but of a more edifying sort: pictures of everyday life, including manufactures, domestic operations, natural history, chemistry, physics, mineralogy, and so on. A short—very short—description is placed underneath each figure. On the whole the book has a very lively appearance about it and deserves to be widely known.

Revolving Planisphere. (George Philip & Son.) 2s. An oval opening in the disc of this apparatus represents the horizon for which the planisphere is constructed, and the part of the heavens visible at any stated time may be found by adjusting the movable disc till the day of the month marked upon its edge corresponds with the time of day or night figured upon a superposed disc. An auxiliary disc, adjustable once a week, serves the purpose of a perpetual calendar. The apparatus is ingenious in construction and extremely attractive in appearance.

We have received from Mr. L. Casella a catalogue of automatic recording instruments of various types, described as well as figured, among which is a pyrometer, recording results up to 4500° F., the automatic rain gauge, barograph, thermograph, electrograph, anemograph, and many others; also the actinometer for measuring the heat and light of the sun. A new photo-theodolite here figured is of considerable value for determining the dimensions of objects accurately by means of photographs which give true perspective pictures, and obviate the use of a large number of note-books in surveying operations.

BOOKS RECEIVED.

Andrée and his Balloon. By Henri Lachambre and Alexis Machuron. (Constable.) Illustrated. 6s.

Glass Blowing and Glass Working. By Thomas Bolas. (Dawbarn & Ward.) Illustrated. 2s. net.

On Laboratory Arts. By Richard Threlfall, M.A. (Macmillan.) Illustrated. 6s.

The Arrangement of Atoms in Space. By J. H. Van't Hoff. Translated by Arnold Eiloart. (Longmans.) 6s. 6d.

The Moon. By Richard A. Proctor. Fourth Edition. (Longmans.) Illustrated. 3s. 6d.

The War of the Worlds. By H. G. Wells. (Heinemann.) 6s.

Elementary Physics. By John G. Kerr, M.A. (Blackie.) Illustrated. 1s. 6d.

The Story of the British Coinage. By Gertrude B. Rawlings. (Newnes.) Illustrated. 1s.

Calendar, History, and General Summary of Regulations, Science and Art Department. (Eyre & Spottiswoode.) 1s. 7d.

The Science of the Ideal. By F. J. Linford-Wilson. (Reeves.) Illustrated. 2s. 6d.

Storm and Sunshine in the Dales. By P. H. Lockwood. (Elliot Stock.) Illustrated.

Remarkable Comets. By W. T. Lynn. Sixth Edition. (Stanford.) 6d.

Elementary Botany. By Percy Groom, M A. (Bell.) Illustrated. 3s. 6d.

Charles Dickens. By George Gissing. (Blackie.) 2s. 6d.

Terje Viken. From the Norse of Henrik Ibsen. By Alfred Lishman. (The Author: Fockerby, Goole.)

XUM

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

Mistle Thrush swallowing Droppings of Young.—Last spring I was much interested in watching a pair of Mistle Thrushes which had their nest on a branch of a tree some twenty feet from the house. From an upper window one could get an uninterrupted view down into the nest. When the young were hatched I watched the nest very carefully, and with a pair of field glasses, which revealed every detail of the birds and the nest, I made the following observations. As soon as one of the parent birds appeared in the tree the four young ones stretched up their necks and opened their gaping yellow mouths. The old bird cautiously made its way to the edge of the nest, and put a piece of a worm first into one mouth, then into another (generally only two at a feeding), seeming by its actions to discriminate which young ones to feed. Immediately it had emptied its mouth the parent put its head down to the nest, and one of the young turned round and voided its white droppings into the open beak of the parent bird, which then swallowed the droppings and flew away. In two minutes the other parent appeared, and went through exactly the same process. For a fortnight I watched this extraordinary method of sanitation many times a day. On no occasion did either parent leave the nest after feeding the young without swallowing the droppings of one young bird and only one. Moreover, on several occasions the old bird, after having waited a few seconds without result, gave a gentle peck to one of the young, which immediately turned round and voided its droppings into the parent's mouth. At about every fourth visit to the nest one of the parents covered the young for a quarter of an hour after having fed them and swallowed the droppings, and on several occasions I kept my eyes upon the parent during the whole time, but never saw it attempt to disgorge. During the last week in which the young ones were in the nest the droppings were, apparently, sometimes too large to swallow, and consequently they were often carried away in the beak; but every now and then they were swallowed.

I have set these facts out in detail because, although it is well known that birds carry away the droppings of the young, the fact that they are usually swallowed by certain birds seems to have been overlooked. In the second volume of Macgillivray's "British Birds," that excellent naturalist, the late J. Jenner Weir, in communications to the author concerning the habits of the Blackbird, Song Thrush, and Mistle Thrush (the nests of which he had watched most carefully), mentions the fact that in each of these species he observed that the old birds "swallowed nearly all the droppings of their brood" during the day; moreover, he shot one of the birds and found the droppings in its stomach. In the fourth edition of Yarrell's "British Birds" we are merely told that Song Thrushes "have been observed to swallow the fæces of their offspring."

In no other book can I find the fact mentioned. It seems to me that either the habit has been overlooked or else it requires confirmation, and I have therefore ventured to publish this note.

It is evident that the droppings go into the stomach, and it is also evident that they are sometimes retained for at least a quarter of an hour. It is questionable if the bird would be able to disgorge them after they had been in the stomach for fifteen minutes. It is conceivable that the droppings are taken by the parent bird as food, for it would be able to digest what the young bird had, perhaps, been unable to assimilate, and would thus save a great deal of time in procuring nourishment for itself.

It seems to me that for those well situated for observing birds it would be most profitable to ascertain during the coming spring what species do swallow the droppings of the young, if they do this regularly, and if there is sufficient nutriment in them to induce the birds to swallow them for the sake of nourishment. If the droppings are swallowed for this purpose it may be that they are only swallowed when food is scarce. I shall be very glad of any further information on this interesting subject.—Harry F. Witherby.

Quail in Sussex.—We have had brought us to-day for preservation a Quail (*C. communis*), caught in the lark nets near here yesterday. We suppose that the mildness of the winter is the cause of its remaining in this country. —Edwin A. Pratt, Brighton, January 28th, 1898.

Curious Jackdaw's Nest.—Last season but one, while looking over the grounds at Bretton Hall, near Barnsley, I saw sticks protruding from the top of the old chimney formerly belonging to the greenhouses. I suspected it to be a nest. On making inquiries from the gardener he told me it was the nest of a pair of Jackdaws, which had filled the chimney with sticks and made their nest on the top. On looking in at a doorway at the bottom of the chimney I saw it was quite filled from the base, and the man told me he had cleared it out several times, but they always filled it again.—S. L. Mosley, Educational Museum, Huddersfield.

Early Nesting of the Starling, the Long-tailed Tit, and the House Sparrow.—The Rev. Francis C. R. Jourdain writes from Asburne, Derbyshire, that a Starling's nest, with nearly fledged young, was found at Bradley at the end of January. Mr. W. Dunn, of Exmouth, writes that on February 7th he watched a pair of Long-tailed Tits collecting moss, evidently for a nest. A brood of House Sparrows is also reported from Blackheath, Kent, as having been hatched on February 15th.

Crane in County Tipperary (*Irish Naturalist*, February, 1898, p. 51).—A specimen of *Grus communis* is reported by Mr. W. Johnston, of Thurles, to have been shot at Seskin in September, 1896.

Little Bittern in County Cork (*Irish Naturalist*, February, 1898, p. 51).—Mr. John J. Wolfe records that a bird of this species was shot on November 8th, 1897, by Mr. W. Sweetman, of Schull, and sent to him.

Little Bustard in Norfolk (*The Field*, February 19th, 1898, p. 285).—Lieut.-Col. E. A. Butler records that a specimen of the Little Bustard (*Otis tetrax*) was shot on January 25th by Mr. Godwin at Feltwell, near Downham Market, Norfolk.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

Note.—The first issue of Knowledge containing British Ornithological Notes was that for October, 1897.

Obituary.

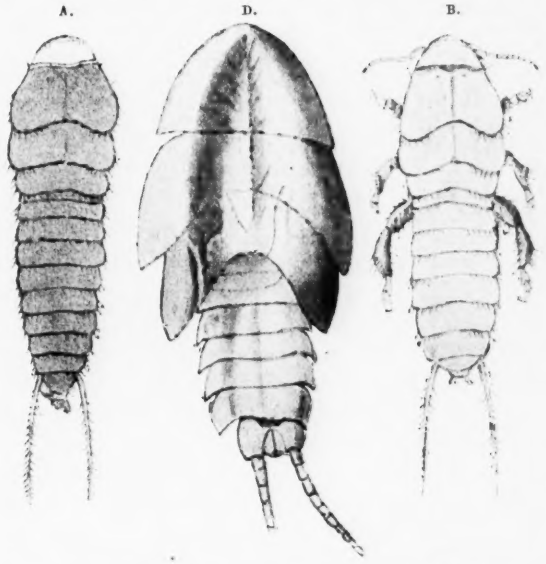
We regret to record the death of Prof. T. Jeffrey Parker, F.R.S., whose decease occurred on the 7th November last. He was the eldest son of the well-known osteologist, William Kitchen Parker, and was born in London in the year 1850. Obtaining the associateship of the Royal School of Mines in 1871, he, after a short appointment as science master in Yorkshire, returned to London and became demonstrator under Prof. Huxley, at the latter's invitation, at the Royal School of Mines. In 1880 he left England for New Zealand, to take up the duties of Professor of Biology in the University of Otago, which post he retained till his death. Prof. Parker was the author of a great number of original scientific memoirs, some of which are of far-reaching importance. He also wrote some valuable text-books on natural science, one of which, to wit, "Lessons in Elementary Biology," has been translated into German. In conjunction with Prof. Haswell, of Sydney University, he attempted the laborious task of writing a large text-book of zoology, which he was not destined to see in circulation. Prof. Parker was entrusted with the task of forming a museum of biology at the Royal School of Mines, on the type system. He advocated the study of the lower organisms first in preference to the vertebrates, as inculcated by Huxley, and in due course secured a triumph over his great teacher on this point. As a worker, Prof. Parker was of the first rank, and also a luminous teacher. He was a kind, considerate, and lovable man, and the biological world is the poorer by his untimely death.

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—II.

By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S.

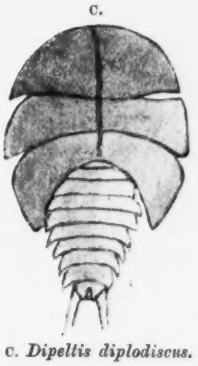
In the previous chapter examples were given to show the extreme divergence of form and structure to be found in the Crustacea at large. The differences are scarcely less striking that may be seen within the limits of the Malacostraca. Yet that group, by the close interweaving of affinities, is as inseparably compacted together as any in the animal kingdom. Especially notable is one character which may be traced through all its divisions. The somites, or segments of the body, are in a numerical bondage; they are never allowed to exceed twenty-one. That might not seem wonderful were it not that, in the segmented appendages of these same animals, there is frequently shown the most contemptuous indifference to arithmetical restraints.

As to the mystic number twenty-one, though it is never transgressed, the chance spectator will never find it fully developed for straightforward counting and ocular demonstration. It is only discoverable by inferences and comparisons. Always some of the segments are in more or less complete coalescence. This fusion might lead to confusion, did not the following rule provide a guiding light. Wherever a segment can be definitely proved to be single, it never bears more than a single pair of appendages; elsewhere, then, the presence of two or more pairs of appendages in apparent attachment to a single segment may safely be taken to imply that such a segment is in reality composite. Moreover, composite segments which have lost their appendages present no great difficulty, because they can be compared with corresponding segments which in other genera and species have retained their appendages. Often, in a male crab, the pleon or tail-part has such an unfurnished compounded segment, which plainly tallies with separate appendage-bearing segments in the other sex. When, therefore, we read of a genus in



A. *Hemimerus talpoides* ♂. D. *Dipeltis carri* (from Schuchert).
B. *Hemimerus talpoides* ♀.

which the male pleon has five segments and the female seven, it does not mean that nature has been more stingy to one sex than to the other, but only that in the masculine tail three segments have been soldered into one. With regard to the last segment, or telson, there is this difficulty: it never has distinct appendages. Consequently its character has been aspersed, as though it were not a segment at all, but only a caudal excrescence—like the child which fancied itself a first-class carriage, while its playmates regarded it as nothing but a truck. The first segment, like the last, has had its claim disputed. It is rarely free and independent. It carries the eyes, which some naturalists do not consider to be true appendages. Often, indeed, the eyes are "sessile"—that is, seated under the skin of the head, with nothing limb-like about them. On the other hand, the "ocular segment" is sometimes movably articulated, and often the eyes are placed on jointed stalks, freely movable, and sometimes of great length. Between the two debatable points there lie nineteen undisputed segments, verified by nineteen pairs of undoubted appendages. These begin with two pairs of antennæ and a pair of mandibles. It is a matter of convenience that throughout the Malacostraca every segment should have its constant number, from the first to the twenty-first. Consequently, although in the sessile-eyed division the first is always either wanting or undecipherable, that need not interfere with our reckoning the mandibular segment uniformly as the fourth.



C. *Dipeltis diplodiscus.*

Here it should not be entirely overlooked that, though insects have no stalked eyes and have only one pair of

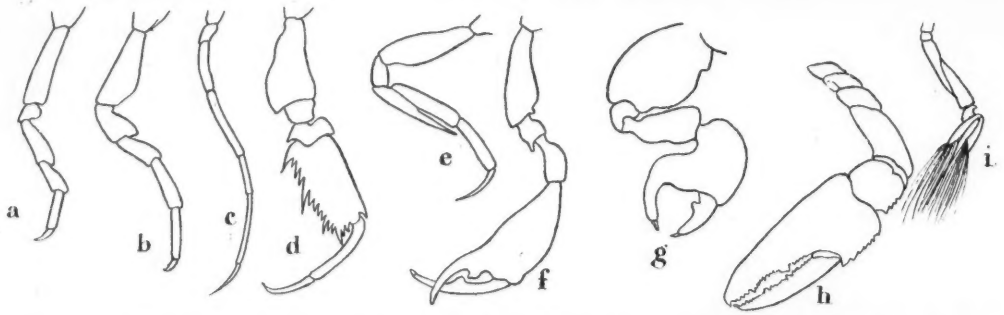
antennæ, there are some among them, as H. J. Hansen* has shown, in which nineteen segments may be inferred exactly comparable to the last nineteen of the Crustacea Malacostraca. With the living forms of the male and female *Hemimerus talpoides* (Walker) (A and B), regarded by Hansen as a wingless orthopterous insect, it can scarcely be uninteresting to compare the species *Dipeltis diplodiscus* (Packard) (C) and *Dipeltis carri* (Schuchert) (D),† fossils derived from the lower Carboniferous system, and placed by those authors among the entomostracan Apodidæ. The entomologists now, with some reason, claim these fossils for their own, so that the common ancestors of insects and Crustacea remain as heretofore the phantoms of an undiscovered past.

Reverting to our more immediate subject, a remark must be made on the mandibular segment. Owing apparently to that predominance which the jaw so often asserts in the affairs of life, this segment, not content with its nineteenth or other fractional share of the back, has spread itself in an obtrusive and in what might be called an overbearing manner. It assumes the title of carapace, or cephalothoracic buckler. It is no doubt a valuable shield, but, like other saviours of society whose natural motto is "*L'état, c'est moi*," the carapace of the crab sometimes takes leave to pose as if it were the whole animal. Of this an extreme example is afforded by the Californian *Cryptolithodes typicus*, of which a portrait by Stimpson is here presented. As will be perceived, the great shield, in dorsal view, completely hides all the working members of the organism except the little twinkling eyes.

Cryptolithodes typicus. (Dorsal view.)

The ten pairs of appendages which follow the mandibles are objects of study of almost inexhaustible interest, not only because of the variety of form and function they exhibit in any one specimen, but because of the surprising variety of that variety as we pass from group to group. It will be easily understood that this diversity of function is matched by some diversity of form, and the use of distinctive names, such as maxillæ, maxillipeds, and trunk-legs, becomes indispensable. Some, in fact, are a kind of jaws—organs of the mouth—while others are a kind of arms or legs—organs of the trunk; but the curious thing is that the middle pairs may be either one thing or the other, according to the group which owns them. The term "maxillipeds," or jaw-legs, enshrines the idea that these appendages, though used as jaws, are nothing but modified legs; and the corresponding term "gnathopods," with the same meaning, hints at legs which are longing to be jaws. The hypothesis we have to consider is that all the appendages, including, with those already mentioned, the six pairs belonging to the pleon, are modifications of one original pattern. Between the primitive simplicity to be expected of such a pattern and the complicated structure observable in a crab's maxillæ, it might at first sight seem hopeless to find the requisite connecting links. But extended comparison of features difficult to interpret with those that are common and commonplace has long ago brought out a sort of ground-plan of a crustacean appendage. According to this it principally consists of a stem and two branches. Three joints are perhaps the normal number for the stem, but it often displays only two, and occasionally only one. The joints of the branches are indefinitely variable in number. But, limiting ourselves for the present to the Malacostraca, it may be said that, in the organs of the mouth and in the limbs of the trunk, the inner or main branch of an appendage shows a preference for not exceeding five in the number of its joints. Add these to two in the stem, and entrust the seven to the plasticity of nature, and then see what will follow. A man has only to look at the noses and chins of his friends and neighbours to know what may be expected from modifications of shape and size.

Imagine, then, a primitive limb of seven approximately uniform joints. In all but the last of these room must be found for the retractor and extensor muscles. For firmness of attachment to the trunk it may generally be convenient that the first joint should be short. The last, which does not require muscles, may be thinner than the



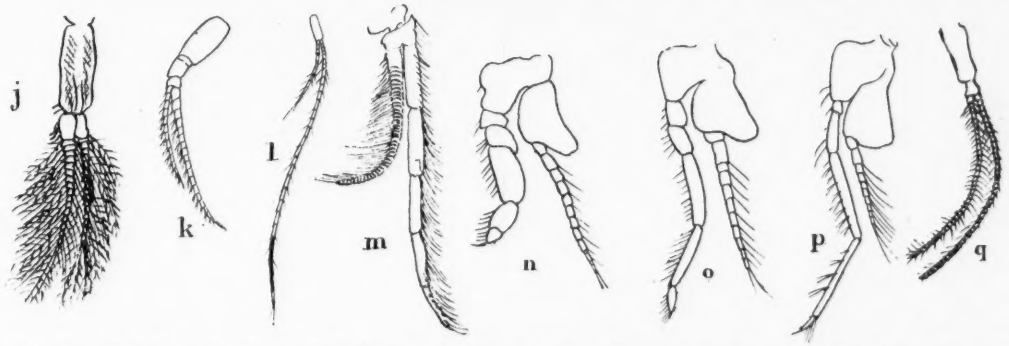
a. Talitrus. b. Porcellio. c. Crangon. d. Primno. e. Aora. f. Phronima. g. Sphyrapus. h. Potamobius. i. Atya.

Among the functions more or less generally allotted to them may be reckoned those of tasting and pasting, biting and fighting, grasping and clasping, walking and a kind of inarticulate talking, swimming, burrowing, house building, besides the automatic services which they render to the eggs in the brood pouch and to the animal's own respiratory. Being in frequent contact with external surfaces, it may acquire a hardened apex and become claw-like, or, for purposes of navigation, it may assume a broad, flat, blade-like appearance. The other joints will certainly not for ever maintain uniformity of length, and those which are longer will at least sometimes have a proportionate increase in breadth. By the course thus indicated we arrive at the ordinary leg of an ordinary amphipod, such as a sandhopper (*see* Fig. *a*), or that of an ordinary isopod, such as a woodlouse (*see* Fig. *b*), or that of a

* "Contributions to the Knowledge of the Insect Fauna of Cameroun." *Entomol. Tidsker.*, Pl. II., Figs. 1, 2, 1894.

† *Proceedings U.S. National Museum*, Vol. XIX., Pl. LVIII., Figs. 4, 6, 1897.

Crangon, an ordinary shrimp (*see* Fig. *c*). But besides being lengthened and widened, the joints may be variously sculptured, as in the fifth joint of the next specimen, which represents the uncommon leg of an uncommon amphipod (*see* Fig. *d*); or one joint may be outdrawn at its apex to overlap the next, thus producing various forms of what is known as a chela or claw. In Fig. *e* the fourth joint is prolonged; in Fig. *f* the fifth joint. These are two peculiar forms among the Amphipoda. The next example shows the quaintly shaped leg of a deep-sea isopod, where the so-called "thumb" is on the sixth joint, though, owing to coalescence, it looks like the fifth. The following figure shows the same thing in the more familiar leg of the river crayfish. Sometimes the joints are attached to one another, not end to end, but at various angles, as in the leg of a tropical prawn (*see* Fig. *i*), which has thumb and finger furnished each with a brush of long hairs, in nature as useful as they are beautiful. Of the limbs here shown none have the outer branch developed: some have over the first joint an expansion called a side-plate; some have gills or breathing organs attached to them; most have some sort of garniture of hairs and spines; but these details are omitted as foreign to our present purpose. Most of the figures are considerably magnified portraits; that from the crayfish is much reduced.



j. Swimming Foot of *Amphipod*. *k*. First Antenna, *Liljeborgio*. *l*. Tail-Foot, *Apseudes*. *m*. Maxallipeds, 3, 4, *Penæus*. *n*. *o*. *p*. Maxillipeds, 2, 3, and following limb, *Sorialla*. *q*. Leg of *Lepas*.

Crayfishes, lobsters, prawns, and shrimps, all belong to the *Decapoda macrura*, the ten-footed long-tailed tribe. In these the muscular pleon or tail part, through its strong development, possesses a commercial value and cannot escape observation. The crabs, on the other hand, which have no meat to boast of in the flexed and flattened pleon, are often erroneously supposed to be devoid of tails. That they are not open to this reproach is obvious, since they form the ten-footed short-tailed tribe, *Decapoda brachyura*. But be the tail short or be the tail long, all these stalk-eyed creatures agree in having, after the mandibles, two pairs of maxillæ and three pairs of maxillipeds and five pairs of peds, pods, feet or legs. In this respect one of the sessile-eyed groups—the highly curious Cumacea—agrees with them. But the sessile-eyed isopods and amphipods have, instead of three pairs of maxillipeds and five of legs, one pair of maxillipeds and seven pairs of legs. Upon comparison, then, it becomes perfectly clear that the appendages of the eighth and ninth segments are strictly homologous throughout the Malacostraca. We may call them maxillipeds or gnathopods or trunk-legs, according to their differences of form and function, but they are none the less essentially equivalent structures. In some of the Amphipoda and Isopoda the maxillipeds are more leg-like than the legs which come next to them, and the same may be said of the third maxillipeds in the Decapoda. But whether the appendage be adapted for eating, grasping, digging, or walking, its form can easily be referred to a simple linear original, and this applies also to the maxillæ and the mandibles, although in them the leg-like or linear pattern has become strangely disguised.

The typical appendage was spoken of as consisting principally of a stem and two branches. Other appurtenances of the stem must be left for future notice, but the second or outer branch claims more immediate attention. As we have seen, it may remain entirely undeveloped. At other times it invites observation, as in the shrimp-like Schizopoda, which bear this name of "cleft-legs" because their trunk-limbs display both branches. But really there are very few crustaceans which do not, in one appendage or another, display them both. Throughout the Amphipoda the first three pairs of appendages of the pleon have a very uniform character. They almost invariably consist of a two-jointed stem and two subequal lash-like branches. The lashes are constituted of a great many small similar joints, each furnished with a couple of long hairs, and they are generally effective swimming organs (*see* Fig. *j*). In these pleopods, or legs of the pleon, one may imagine that one sees a pattern of crustacean appendage more primitive than the leg-like one before suggested. Both pairs of antennæ usually end in lashes. The first pair often has two (*see* Fig. *k*). Occasionally, as in the isopod *Apseudes*, there are two such lashes at the opposite extremity of the animal, in the last pair of tail-feet (*see* Fig. *l*). Repeatedly in the triple maxillipeds of the Decapoda, while one branch is pediform, the other has a terminal lash (see Fig. *m*). In the Schizopoda this structure is to be found not only in the two pairs of limbs which are equivalent to the second and third maxillipeds (*see* Figs. *n*, *o*, *p*), but in all the five pairs which follow (*see* Fig. *q*), these being succeeded by five pairs of pleopods, each with two lash-like branches. One abnormal case is often quoted, in which the eye-stalk of a crayfish developed into an antenna-like lash. This has recently been matched by an equally abnormal case in which a "trunk-leg" has been developed on the pleon of a crab.

From a wide-reaching subject enough has perhaps been culled to lead the industrious beginner into an engaging path of inquiry—the comparative anatomy of Crustacea. It will be strange if he can avoid drawing the conclusion that at least all the Malacostraca are of a common origin. It will be strange, too, if the cirri, or legs of the barnacle,

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with their stem and two lash-like branches (*see* Fig. *q*), do not awake in him at least a suspicion that the crustacean family is not only not confined to a few articles of domestic consumption, but may have ramifications even beyond the bounds of the Malacostraca.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Comets.—Pons-Winnecke's comet at the beginning of March will enter the head of Capricornus and pass between the bright stars α and β of that constellation; but as these objects will be only forty degrees west of the sun, and rise about two hours before him, there will be but a slender prospect of observing the comet. The distance of this object from the earth is now increasing, and it is not likely to be seen again in ordinary telescopes until the early part of 1904.

Comet II. 1892 (Denning).—In *Ast. Nach.* 3472, Dr. Steiner, of O'Gyalla, Hungary, gives a definite orbit which he has derived for this object from a discussion of one hundred and eighty-six observations. Though a very small, faint comet, it was visible for a long period, and its positions were secured during the ten months from 1892, March 19th, to 1893, January 12th. Dr. Steiner concludes that the orbit is hyberbolic, for, with the excentricity at 1·000345, the sum of the squares of the residuals is 103·2″ for an hyperbola, and 279·5″ for the parabola. The observations near the middle of the series, in the summer of 1892, exhibit rather large residuals, and Dr. Scheiner regards this as unsatisfactory. But the comet was difficult to observe at that time owing to the twilight, and to its faintness, due to great distance from the earth; for at the middle of June the comet was separated from us by an interval of two hundred and seventy millions of miles. The path of the comet was nearly vertical to the ecliptic, the inclination being eighty-nine and three-quarter degrees. Dr. Scheiner's definitive elements are :—

T	... ...	1892, May 11·261935 M.T. Berlin.
π	... ...	22° 45′ 42·40″
Ω	... ...	253° 25′ 50·92″
ι	... ...	89° 41′ 54·10″
log. q.	...	0·2946197
e	... ...	1·000345

Meteors.—Though the shower of Leonids in 1897 was not very brilliant, and completely obscured by clouds at the majority of stations on the mornings of November 15th and 16th, it returned with fair activity on those dates. There is little doubt, however, that the earth did not encounter the really dense portion of the stream, but it is difficult to specify what strength is fairly representative of the main swarm, and a certain standard (or rate of apparition) will have to be adopted to express it. The richest part of the current is probably not a sudden development, but due to gradually increasing abundance along a considerable stretch of the orbit. It is important to ascertain the time when the earth encounters that section of the stream in which the meteors begin to be thickly congregated. In 1833 there were one thousand meteors per minute, while at about the period of maximum frequency on November 13th, 1866, there were one hundred per minute for one observer. What, therefore, will be the rate of appearance assumed for the fore region of the main swarm? Perhaps ten meteors per minute might satisfactorily represent it, for this would give six hundred per hour, it being understood that the figures are for one observer watching a clear, moonless sky with the radiant at a fair altitude. It is certain from the conditions of the case that the relative intensity of the stream at different parts can only be ascertained after many cyclical returns of the swarm, for the earth is only involved in it for a short time once a year, and in the interim of successive encounters a vast range of the current passes the node without recognition.

Now that the effort is being made to photograph the group of Leonid meteors in space, it might be as well to endeavour to get an impression of the parent comet. On March 16th the comet will be certainly less than two hundred millions of miles distant, and possibly less than one hundred and fifty millions, whereas the meteoric swarm will be about five hundred and sixty-eight millions distant on the same date. In view of the fact that the comet is more highly condensed and probably far more luminous than its accompanying meteoric stream, the prospect of detecting it is much more favourable. Towards the close of the present year, however, the comet will approach much nearer to the earth than it is at present, and no doubt some special efforts will then be made to redetect it.

Fireball of 1898, January 21st.—In the twilight of Friday evening, January 21st, at 5h. 32m., one of those large fireballs which occasionally burst out and illuminate sky and landscape with startling brilliancy, was observed at a great many places in the South of England, and in some parts of Ireland and Wales. A considerable number of descriptions of the object were published in the newspapers, and if, as usual, the writers failed to record the exact position of the meteor's path and its duration of flight, they one and all testified to the astonishing brilliancy of the phenomenon. Not many stars were visible at the moment of the meteor's descent, so it was difficult to fix its apparent course with the necessary precision. But several of the observers were fortunate enough to obtain a good view of it, and recorded the path as accurately as circumstances permitted. From thirty-three accounts which I have compared together, it appears certain that the fireball traversed a very long path from east to west over the south coast of England. Observers in London and that district say that the object first appeared at a great altitude in south-east or south, and disappeared in south-west; while spectators in the western counties describe the motion as from east or east by south to south-west, or south-west by south. The flaming nucleus was not so large as the moon, but was, according to several reports, about twelve or fifteen minutes of arc in diameter, but its brightness exceeded that of the full moon. The colour appears to have varied, and observers are by no means agreed in their estimations, but the head seems to have been yellowish and the train bright green and purple. The meteor burst before vanishing; and it travelled, not with that very slow, sailing flight which is often characteristic of the largest fireballs, but with moderate velocity, and its entire visible course probably occupied seven seconds. One person, however, says it lasted thirty seconds; another estimated the duration as nearly five minutes! The best estimates vary from three to seven seconds, but most of the observers only caught the meteor after it had already traversed a part of its course, and when it was descending at a low altitude in the south-west.

The fireball when first seen appears to have been eighty-two miles above a point five miles south of Croydon in Surrey. Moving to the south-west by west it passed over Petersfield, Lymington, and St. Alban's Head, and disappeared at a height of twenty-five miles over the English Channel some thirty-five miles south of Eddystone Lighthouse. Its length of path was two hundred and thirty-five miles, and velocity about thirty-four miles per second. The radiant point was in the north-east region

of Cancer at 130° + 30°, in azimuth about 31° north of east, and altitude 14° at the time of apparition. The fireball was probably a member of a meteoric shower seen at Bristol in 1887-9, January 25th to February 1st, at 131° + 32°. A fireball seen in 1877, January 19th, may also have been derived from the same system, for its real path, computed by Prof. Herschel, presents a striking resemblance to that of the recent meteor, as follows :—

	Height at first. Miles.	Height at end. Miles.	Path. Miles.	Velocity. Miles.	Radiant.	Position of Path.
Jan. 21, 1898	82	25	235	34	130°+30°	South of England.
Jan. 19, 1877	75	45	230	35	135°+27°	Wales and South of Ireland.

Two large and brilliant meteors were observed on the night of Sunday, February 20th, 1898, at 8h. 54m., and 10h. 20m., and particulars of these will be given next month.

THE FACE OF THE SKY FOR MARCH.

By HERBERT SADLER, F.R.A.S.

SUNSPOTS may occasionally be observed on the solar disc.

Conveniently observable minima of Algol occur at midnight on the **1st**, at 8h. 50m. P.M. on the **4th**, and at 10h. 32m. P.M. on the **24th**.

Mercury is too near the Sun to be observed this month, being in superior conjunction with the Sun on the **16th**.

Venus is too near the Sun for the observer's purposes, and Mars is also practically invisible.

Jupiter is an evening star, and is excellently situated for observation, being in opposition to the Sun on the **25th**. On the **1st** he rises at about 8h. P.M., with a southern declination at noon of 1° 52′, and an apparent equatorial diameter of 43½″. On the **12th** he rises at 7h. 9m. P.M., with a southern declination of 1° 22′, and an apparent diameter of 44″. On the **22nd** he rises at 6h. 24m. P.M., with a southern declination of 0° 51′, and an apparent diameter of 44¼″. On the **31st** he rises at 5h. 44m. P.M., with a southern declination of 0° 24′, and an apparent diameter of 44½″. During the month he describes a retrograde path in Virgo.

Saturn does not rise till just before midnight on the **1st**, so we defer an ephemeris of him till April, and an ephemeris of Uranus is omitted for similar reasons.

Neptune is an evening star, being in quadrature with the Sun on the **10th**. On the **1st** he souths at 6h. 37m., with a northern declination of 21° 43′, and an apparent diameter of 2½″. On the **31st** he souths at 4h. 40m. P.M., with a northern declination of 21° 45′. He is almost stationary in Taurus during the month.

There are no very well marked showers of shooting stars in March.

The Moon is full at 9h. 29m. A.M. **on the 8th**; enters her last quarter at 7h. 48m. P.M. **on the 15th**; is new at 8h. 37m. A.M. **on the 22nd**; and enters her first quarter at 7h. 40m. A.M. on the **30th**. Some of the small stars in the Pleiades will be occulted on the evening of the **26th**.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. Locock, Burwash, Sussex, and posted on or before the 10th of each month.

Solutions of February Problems.

No. 1.
(W. Clugston.)

1. Kt to B4, and mates next move.

No. 2.
(S. Loyd.)

1. P × B (becoming a Knight), K × Kt.
2. Kt to QKt6, anything.
3. P to R8, mate.

White gets a Knight in order to be able to place it between his RP and the Black Bishop on his next move. No correct solutions have been sent, but the problem was well worth solving, as all Mr. Loyd's are.

CORRECT SOLUTIONS of No. 1 received from G. G. Beazley, H. Worsley Wood, W. de P. Crousaz, J. M'Robert, A. E. Whitehouse, H. W. Elcum, Mrs. C. F. Giddings.

Capt. Forde.—If 1. Kt to B8, K to B4, dis. ch.

F. A. Curtis.—1. B to K6 is met by Kt to K7. In No. 2, after 1. Kt to B4, B × P; 2. Kt to K2, the King moves and escapes mate.

H. W. Elcum.—Your solution of No. 2 fails as above.

J. B. (York).—See above. In No. 2, if 1. P to Kt8 (Queens), B to Kt2, and the Queen cannot play to Kt6. But the Bishop may also safely play to Q4 or K5, though not elsewhere. A note appended to the January puzzles gave warning that a "liberal interpretation" of the laws of the game was required for their solution. As a matter of fact, the law says nothing as to the colour of the piece to be chosen. If, therefore, White selects a Black Rook, Black has a perfect right to use it for Castling purposes. We are glad to hear that you appreciate the February Number.

H. Worsley Wood and *A. E. Whitehouse.*—In answer to 1. P to Kt8 (becoming a Queen), Black moves his Bishop to Kt2 or Q4 or K5, and there is no forced mate in two more moves. If he move elsewhere there is.

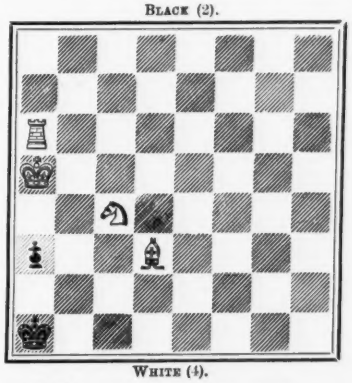
F. W. A. de Tabeck (Rome).—Many thanks for your appreciative card.

D. R. Fotheringham.—The massacre suggested is too terrible to think of. Could you not be contented with 3. PQR3, and less bloodshed?

PROBLEM.

From the *Standard*.

BLACK (2).



WHITE (4).

White mates in three moves.

We propose this month and next to try the effect on our readers of some very full analysis. For this purpose we have selected a short game of nineteen moves, played on Board No. 1 in the Kent *v.* Sussex correspondence match last year. Our analysis is compiled from notes made at the time.

Part I.—The Opening.

White.	Black.
1. P to K4	1. P to K4
2. KKt to B3	2. QKt to B3
3. B to Kt5	3. Kt to B3
4. P to Q4	4. P × P
5. P to K5	5. Kt to K5
6. Castles	6. P to QR3 (*a*)
7. B to R4 (*b*)	7. Kt to B4
8. B × Kt	8. QP × B
9. Kt × P	9. Kt to K3 (*c*)
10. Kt × Kt (*d*)	10. B × Kt
11. Q to K2	11. Q to R5 (*e*)
12. Q to K3 (*f*)	12. Castles (*g*)
13. Q to R7 (*h*)	

Notes.

(*a*) Not to be found at this particular stage in any book on the openings. The time-honoured move is 6 . . . B to K2.

(*b*) This loses a move. 7. BQ3, or B to B4, would be answered by 7. . . . P to Q4. But the best course seems to be 7. B × Kt, QP × B; 8. Kt × P (or A, B), B to K2; 9. B to K3, Q to Q4!

(A) 8. *Q to K2*, QB to B4 (or (i.)) [not 8. . . . Q to Q4, on account of P to QB4, now or later]; 9. B to K3, Q to Q2 (9. Kt × P, Q × Kt!); 10. Kt × P, Castles (QR); 11. P to KB3, etc.

(i.) 8. . . . Kt to B4; 9. R to Qsq, B to Kt5; 10. B to K3, Kt to K3 (or 10. . . . Q to Q4); 11. P to B3, Q to Q4, or KB to B4, etc.

(B) 8. *R to Ksq*, Kt to B4; 9. Q × P (or 9. Kt × P, Kt to K3), Q × Q; 10. Kt × Q, Kt to K3, etc.

(*c*) By a transposition of moves the position in a match game, Morphy *v.* Lowenthal, has been reached. Lowenthal played this move, which is much better than 9. . . . B to K2, as recommended by Morphy, Salvioli, and Steinitz. The two latter authorities give 9. . . . B to K2; 10. QKt to B3, Castles; 11. B to K3, P to KB3; apparently overlooking the powerful reply, 12. Q to K2, threatening Kt × P.

(*d*) This and his next move were played by Morphy against Lowenthal. If, instead, 10. B to K3, Kt × Kt; 11. B × Kt, QB to B4; 12. P to QB3, Q to R5, with a good game. But, on account of Black's 11th move in the actual game, we are inclined to prefer 10. KKt to B3, Q × Q; 11. R × Q, BK2; though Black can develop afterwards by Kt to KBsq, and B to KB4.

(*e*) Much stronger than either 11. . . . B to QB4, as played by Lowenthal, or 11. . . . B to K2, as recommended by him. The Black Queen is never dislodged from this powerful position. Black now threatens B to B5.

(*f*) Evidently intended to prevent Castling (QR), and in a minor degree, perhaps, to support the entry of a Knight at QB5. But in other respects it loses time.

(*g*) A bold course, but 12. . . . B to K2, followed by Castles (KR), and QR to Qsq, would leave the Queen's side pawns unprotected. 12. . . . Q to QB5; 13. Kt to R3 (best), B × Kt; 14. Q × B, leads to a draw, as Black cannot take the BP on account of B to Kt5. Another plan would be 12. . . . R to Qsq; 13. Q to R7 (?), B to Bsq; 14. Q to Kt8, Q to K2.

(*h*) This subjects him to a strong attack. Another course would be—13. Kt to Q2, B to Q4; 14. Q to R7 (or A), P to QB4; 15. Kt to B3 (if 15. R to Qsq, Q to Q5!), B × Kt; 16. P × B, Q to R4!

(A) 14. P to QB4, B × P; 15. P to KKt3, Q to Kt5; 16. Kt × B, Q × Kt; 17. Q to R7, B to B4; 18. Q to R8ch, K to Q2; 19. Q × KtP, Q to Kt4 [or, perhaps, 19. . . . B to Kt3; 20. R to Qsqch, K to K3; 21. R × R, R × R; 22. B to K3, B × B; 23. P × B, Q to K5; with some advantage].

We reserve the rapid and interesting finish for next month.

CHESS INTELLIGENCE.

The following team has been chosen to represent the British Isles in the Cable Match *v.* the United States, on March 18th and 19th:—Messrs, Atkins, Bellingham, Blackburne, Burn, Caro, Jackson, Jacobs, Locock, Mills, and Trenchard. Reserves: Messrs. Cole and Wainwright. Messrs. Caro and Trenchard are new to the match, while Messrs. Blake, Cole, and Lawrence, who were in last year's winning team, are not playing on the present occasion.

The order of the team is not yet decided on, but it is fairly safe to predict that the first three letters of the alphabet will be well to the fore.

The Hastings Chess Festival last month met with its usual success. Messrs. Blackburne, Bird, Gunsberg, and Janowski gave simultaneous exhibitions, and took part in consultation games against each other with amateur partners.

Messrs. Pillsbury and Showalter have begun their second match for the championship of the United States. It will be remembered that their former encounter last year resulted in a hard-earned victory for Mr. Pillsbury by 10 games to 8.

On January 24th the British Chess Club defeated the St. George's Chess Club rather decisively by 8 games to 2, the latter score being made up of 4 drawn games.

KNOWLEDGE, PUBLISHED MONTHLY.

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